Standard Specifications

for

Road and Bridge Construction

AUGUST 2016

Prepared by

The State of Delaware

DEPARTMENT OF TRANSPORTATION

Excellence in Transportation - Every Trip • Every Mode • Every Dollar • Everyone

Jennifer Cohan, Secretary
Robert McCleary, Chief Engineer

DIVISION 1000 – MATERIALS

DIVISION 100 - GENERAL PROVISIONS

SECTION 101 – GENERAL INFORMATION, DEFINITIONS, AND TERMS

101.01 General. The titles and headings of the Sections and subparts of Sections are intended for reference and are not to be used to interpret the Specifications. When the Contract references a publication, the reference applies to the most recent date of issue as of the date bids are advertised, 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. Prior to the Execution of the Contract, the implied subject of a sentence using the imperative mood is either “the Bidder” or “the prospective Bidder”. The word "will" generally applies to decisions or actions of the Department or Engineer.

In the Contract, 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.

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

The Specifications may present numerical values in both U.S. customary units (English) and metric units. The Plans will only use one of the two systems. Work entirely within the system set forth in the Plans and do not convert between the two systems. The relationship between the U.S. customary values and the metric values within these Specifications is neither an exact (hard) conversion nor a completely rationalized (soft) conversion.

101.02 Abbreviations. Wherever the following abbreviations, terms or pronouns are used in the Contract, interpret the intent and meaning 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
ALSC	American Lumber Standard Committee
ANSI	American National Standards Institute

APWA	American Public Works Association
ARA	American Railway Association
AREMA	American Railway Engineering and Maintenance of Way 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
IEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
MASH	Manual for Assessing Safety Hardware
MIL	Military Specifications
MUTCD	Delaware (DE) Manual on Uniform Traffic Control Devices For Streets and Highways
NASSCO	National Association of Sewer Service Companies
NCHRP	National Cooperative Highway Research Program
NEC	National Electrical Code
NEMA	National Electrical Manufacturer’s Association
NFPA	National Fire Protection Association
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
Temporary Traffic Control (TTC)	Delaware Manual on Uniform Traffic Control, Part 6, Temporary Traffic Control
UL	Underwriters Laboratory, Incorporated

101.03 Definitions. The following definitions apply to the Contract Documents.

Addendum. An Addendum is a Bid Proposal revision issued after Advertisement and before the bid opening.

Additional Work or Extra Work. Additional Work or Extra Work is Work that was not included in the Contract, but is necessary in order to satisfactorily perform the Work required by the Contract or Work that is not included in the Contract, but is desired by the Engineer in order to satisfactorily complete the Work.

Adjustment (or Equitable Adjustment). An Adjustment, Contract Adjustment or Equitable Adjustment is a revision to the Project cost or Project time provided in accordance with Section 109.04 for Project cost and/or 108.07 for Project time.

Advertisement. An Advertisement is a public announcement inviting Proposals for Work to be performed or Material to be furnished.

Award. An Award is the Department's acceptance of a Proposal prior to the execution of a formal, written Contract.

Bidder. A Bidder is any individual or legal entity submitting a Proposal.

Bid Documentation. Bid Documentation includes 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 to the Department, 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 of Unit Prices
F. Subcontractor and Material supplier quotations

Any standard manuals used by the Bidder in determining the contents of the Proposal are also considered Bid Documentation. These manuals may be included by reference in the Bid Documentation. In such cases, 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 Proposal.

Bid Proposal; Bid Proposal Form. A Bid Proposal is the Department's specific Invitation to Bid and consists of the following documents and any referenced documents: the General Description; General Notices; Supplemental Specifications; Special Provisions including Utility, Right of Way, Environmental and Railroad Statements; Plans, Addendums and any Appendices or Attachments; and the Bid Proposal Form. A Bid Proposal Form is the approved form on which the Department requires formal bids to be prepared and submitted for the Work. The Department may allow or require Bid Proposal Forms to be in an electronic format.

Bond. See Contract Payment and Performance Bond.

Bridge. A Bridge is a Structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway; having a track or passageway for carrying traffic or other moving loads; having an opening of 20 square feet or greater; and a minimum vertical opening of 4 feet.

Calendar Day. A Calendar Day consists of each and every day shown on the calendar, beginning and ending at midnight.

Change Order. A Change Order is a written order issued by the Engineer to the Contractor setting forth any change, reduction of Work, and/or addition of Extra Work required to be undertaken by the Contractor. A Change Order may be issued with or without the consent of the Contractor. The signature line for the Contractor on a Change Order form is for the sole purpose of acknowledging receipt of the Change Order; do not write anything on the form other than a signature and do not modify the form on which the Engineer issues the Change Order. Failure to sign the Change Order does not invalidate the Change Order. A Change Order does not invalidate any other portion of the Contract.

Claim. Refer to Section 105.15 for definition of Claim.

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.

Contract; Contract Documents. The Contract is the written agreement between the Department and the Contractor setting forth the obligation of the parties for the performance of the Work. The written agreement constitutes the entire Contract between the parties.

The Contract may include, but is not limited to, the Advertisement; the Contract form; the Contractor's Proposal, the Department's Bid Proposal, Performance, Payment, and other bonds or guaranties; the Specifications; Working Drawings; general and detailed Plans; all required notices with respect to any of the foregoing; Change Orders; Supplemental Agreements; all documents incorporated into the Contract by reference; and the Engineer's written directives. Do not modify, alter, or otherwise change the Contract 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.

Contract Item (Pay Item or Item). A Contract Item, Pay Item, or Item is a specifically described item of Work for which a price is provided in the Contract.

Contract Payment and Performance Bond. A Contract Payment and Performance Bond is 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 or because of the Contract.

Contract Time. The Contract Time is the number of Working Days or number of Calendar Days allowed for the Substantial Completion of the Contract. Achieve Substantial Completion on Calendar Day Contracts on or before the last chargeable Calendar Day even when that date is a Saturday, Sunday, or Holiday.

Contractor. The Contractor is the individual or legal entity contracting with the Department for performance of the Work.

Culvert. A Culvert is either a Structure that is not classified as a Bridge and provides an opening that allows water to flow under a roadway, railway, Embankment or trail or is a Bridge classified as a Culvert in DelDOT's Bridge Inventory.

Days. Days means Calendar Days.

Department (DelDOT). Department means Delaware Department of Transportation (DelDOT).

Differing Site Conditions. Differing Site Conditions are 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. If the Contract contains a definition of Differing Site Conditions in the General Notices, the definition in this Section does not apply and is replaced by the definition found in the General Notices.

District. A District is the subdivision of the Department that is administering the Contract.

District Engineer. The District Engineer is the Department head of the District administering the Contract. The chain of command on a Project will be expressly identified at the preconstruction meeting for the Project.

Embankment. An Embankment is a Structure constructed of Material meeting the requirements of Section 209, as described in Section 202.

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

Equipment. Equipment is all machinery, tools, and apparatus, and the fuels, lubricants, batteries and other supplies and parts needed to use, operate, and maintain these items for use in constructing and completing the Work.

Extra Work. See Additional Work for the definition of Extra Work.

Falsework. Falsework is any temporary construction Work used to support the weight of a permanent structural element until such element becomes self-supporting. Falsework includes, but is not limited to, steel or timber beams, girders, columns, piles and foundations, and any proprietary Equipment including modular shoring frames, post shores, and adjustable horizontal shoring.

Final Acceptance. Refer to Section 105.16 for definition of Final Acceptance.

Final Inspection. A Final Inspection is 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.

Force Account. Force Account is a method of payment for Work performed by the Contractor at the Engineer's direction, calculated as specified in Section 109.04.

Formwork. Formwork is a temporary Structure or mold used to retain plastic or fluid Material in a designated shape until the Material hardens. Formwork must have enough strength to resist the fluid pressure exerted by the plastic Material during placement and any additional pressure generated by vibration of the Material.

General Description. The General Description is the information that appears in the Bid Proposal before the General Notices that consists of specific Project related information that may include, but is not limited to; Location, Description, Completion Time, Prospective Bidders Notes, anticipated Notices to Proceed, Special Notices, Bidding Criteria, Construction Sequence Notes, Road User Costs, modifications to Liquidated Damages, Addenda issued, Questions and Answers published, Prebid Meeting Transcripts, Construction Items Units of Measure and Table of Contents.

General Notices. General Notices are federal and State regulations contained in the Bid Proposal that govern the Contract. The General Notices do not list every State or federal regulation that may affect the Contract.

Holidays. The following Days are Holidays in the State of Delaware.

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

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. 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.

Contractors must receive approval from the Engineer in order to perform Work on a Holiday. The Contractor is not entitled to an extension of Contract Time if the Engineer prohibits Work on a Holiday. Holidays count as Calendar Days on Calendar Day Contracts whether or not the Contractor receives approval to perform Work on those Days.

Inspector. An Inspector is an authorized representative of the Engineer whose duties and authority is defined in Section 105.02.

Invitation for Bids. The Invitation for Bids is the Advertisement of Bid Proposals for Work and/or Materials on which Proposals 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.

Limits of Construction (LOC). The Limits of Construction (LOC) are boundaries that define the area where the Contractor may perform Work. The Contractor may not bring labor, Equipment or Materials outside of the LOC within the Project limits without written permission from the Engineer. When not specifically identified on the

Plans or in any other part of the Contract, the Limits of Construction shall be the outer boundary of the State's Rights-of-Way and easements within the Project's limits.

Liquidated Damages. Liquidated Damages are an amount due and payable to the Department by the Contractor for additional costs incurred by the Department resulting from (a) Withdrawal of a Bid per Section 103.06 or (b) the Contractor's failure to complete the Work within the Contract Time as set forth in Section 108.08.

Major and Minor Contract Items. A Major Item is any Contract Item whose total bid value equals or exceeds 10 percent of the total price bid for the Contract. All other Items are Minor Items.

Materials. Materials are any substances, other than Equipment, used in the construction of the Project.

Notice of Award. A notice of award is the written notice to the selected Bidder stating that the Bidder's 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 that are satisfactory to the Department.

Notice to Proceed (NTP). A Notice to Proceed is a written notice to the Contractor to begin the Contract Work and includes the date on which Contract Time will begin to accrue.

Pavement Structure. A Pavement Structure is the combination of sub-base, base course, and/or surface course placed on a sub-grade to support a traffic load.

A. Sub-grade. A sub-grade is the top surface of the roadbed upon which the Pavement Structure is constructed.
B. Sub-grade Treatment. A sub-grade treatment is the modification of roadbed Material by stabilization.
C. Sub-base. The sub-base is one or more layers of specified material thickness placed on a sub-grade to support a base course (or in the case of rigid pavement, the Portland cement concrete slab).
D. Base Course. The base course is the layer or layers of specified or selected Material of designated thickness placed on a sub-base or a sub-grade to support a surface course.
E. Surface Course. A surface course is the 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".

Plans. Plans are the Contract drawings, 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 to be a part of the Contract.

Profile Grade. A Profile Grade is the elevation of the trace of a vertical plane intersecting the top surface of the finished grade, usually along the longitudinal centerline of the Surface Course.

Project. A Project refers to a 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 performed by others under other contracts.

Proposal. A Proposal is a written offer by a Bidder on Bid Proposal Forms furnished by the Department to perform the Work. The Proposal includes the Bid Proposal Form and all documents submitted by the Bidder, and incorporates by reference all of the documents in the Bid Proposal.

Proposal Guaranty. A Proposal Guaranty is the security furnished with a Proposal to ensure that the Bidder will enter into the Contract if the Contract is Awarded.

Responsive Bid. A Responsive Bid is a Proposal that complies with all requirements of the Invitation to Bid.

Responsible Bidder. A Responsible Bidder is a Bidder determined by the Department to possess the potential to perform the Work.

Right-Of-Way. Right-Of-Way is a general term denoting land, property, or an interest therein possessed by the Department or other entity that was acquired for or devoted to transportation purposes. Rights-of-Way identified in the Contract Documents are presumed to belong to the Department unless the Contract Documents identify such Rights-of-Way as belonging to another entity.

Schedule of Items. The Schedule of Items is the list of Contract Items of Work contained in the Bid Proposal on which Bidders submit their bid prices.

Schedule of Work (Schedule). The Schedule of Work refers to the approved progress Schedule submitted by the Contractor containing dates of commencement and Completion of the various items of Work within the Contract Time.

Secretary. The Secretary is the Secretary of the Department of Transportation of the State of Delaware.

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

Specifications. Specifications are those parts of the Contract that are the compilation of provisions and requirements for the performance of the prescribed Work.

A. Standard Specifications are the Department's posted and/or referenced *Specifications for Road and Bridge Construction* current as of the date of Advertisement of a Bid Proposal and contain the Department's requirements and specifications for general application and repetitive use. Standard Specifications include Supplemental Specifications.
B. Supplemental Specifications are the Department's posted and/or referenced additions and revisions to the Standard Specifications, current as of the date of advertisement of a Bid Proposal and are part of the Standard Specifications.
C. Special Provisions are special directions, provisions, or requirements particular to the Project not otherwise detailed in the Standard or Supplemental Specifications.

Standard Construction Details. Standard Construction Details are drawings of standard details of construction that have been adopted by the Department for miscellaneous items of Work and are a part of the Bid Proposal.

State. State refers to The State of Delaware.

Structures. Structures are Bridges, Culverts, Embankments, storm sewer appurtenances, slope and retaining walls, sign support structures, buildings and other similar items.

Subcontractor. A Subcontractor is an individual or legal entity contracting with the Contractor or another Subcontractor to perform any part of an Item of Work of the Contractor's Contract with the Department. Subcontractors are subject to the requirements of Section 108.01.

Exceptions to this definition are suppliers limited to delivering and depositing, but not incorporating, Material; suppliers of services that transport Material; and Work performed which does not physically advance the Completion of the Contract and is not considered as an Item of Work.

Substantial Completion. Substantial Completion is the point at which all Contract Items are complete as deemed by the Department excluding any warranties or vegetation growth.

Substructure, Bridge. The Substructure of a Bridge is 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.

Superintendent. A Superintendent is the Contractor's authorized representative in responsible charge of the Work.

Superstructure, Bridge. The Superstructure of a Bridge includes the approach slabs and the entire Structure except the Substructure.

Supplemental Agreement. A Supplemental Agreement is 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.

Surety. A Surety is the legal entity other than the Contractor, in good standing and currently licensed to write surety bonds in the State of Delaware Department of Insurance executing a Surety Bond furnished by the Contractor.

Unbalanced Bid, Materially. A Materially Unbalanced Bid is 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.

Unbalanced Bid, Mathematically. A Mathematically Unbalanced Bid is a Proposal containing Contract Items that do not reflect the Bidder's reasonable actual costs plus a reasonable proportionate share of the Bidder's anticipated profit, overhead costs, and other indirect costs.

Unit Bid Price (Unit Price). A Unit Bid Price is the price provided by the Contractor in the Proposal for a Contract Item.

Work. Work is the furnishing of all labor, Materials, Equipment, and other incidentals necessary to complete the Contract.

Working Day. A Working Day is any Calendar Day, except: 1) Saturdays, Sundays, and Holidays; 2) Calendar Days where conditions identified in the Contract require the Contractor to suspend construction operations; 3) Calendar Days with inclement weather that prevent prosecution of the scheduled Work; and 4) Calendar 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 perform Work on any Saturday, Sunday or Holiday, full Working Days will be charged, weather permitting. 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.

Working Drawings. Working Drawings include 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.

101.04 Units of Measure.

Abbreviation	Description
ACRE	Acre
BAG	Bag
BF	Board Foot
CF	Cubic Foot
cSt	Centistokes
CY	Cubic Yard
EA-DY	Each Day
EA-MO	Each Month
EA-NT	Each Night
EACH	Each
F	Fahrenheit
GAL	Gallon
KIP	Thousand Pounds
LF	Linear Foot
LS	Lump Sum
LB	Pound
MFBM	Thousand Feet of Board Measure
MGAL	Thousand Gallons

PCF	Pounds per Cubic Foot
PSI	Pounds per Square Inch
SF	Square Foot
SY	Square Yard
SY-IN	Square Yard – Inch
TON	Ton

SECTION 102 – BIDDING REQUIREMENTS AND CONDITIONS

102.01 Registration of Bidders. Obtain registration status prior to submitting a Proposal. In order to obtain registration status, provide the Department with the information requested on the registration form provided by the Department.

Upon receipt of this information, the prospective Bidder will be listed on the Department's registry. 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 the Bid Proposal. The Bid Proposal will state the location and description of the contemplated Work, show the estimate of the various Pay Item quantities, and show the kinds of Work to be performed and/or Materials to be furnished. A Schedule of Items for which Unit Prices are invited will be included along with the specified Contract 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 Bid 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 Addenda, 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 part of the Proposal. The Plans, Specifications, and other documents incorporated by reference in the Bid Proposal are part of the Proposal whether attached or not.

102.03 Issuance of the Bid Proposal. Potential Bidders must contact the Department in order to receive the Bid Proposal in electronic format. The Department does not provide printed Bid Proposals; bidders are able to print from the electronic format. The Bid Proposal is also available on the internet at the state's Bid Solicitation Directory; however, the Website Bid Proposal is not valid for submitting bids and the Website documents are marked as such. The Department does provide a printed set of plans and specifications for viewing in the Bidder's Room at the DelDOT Administration Building in Dover. The Department will furnish a Bid Proposal to each prospective bidder. The Department reserves the right to refuse to issue a Bid Proposal to a Bidder for any of the reasons stated in Section 102.12.

All Addenda are posted on the internet at the State's Bid Solicitation Directory and are included by reference in the Bid Proposal. The Bidder is responsible to check the website as needed to ensure that the Bidder is aware of Addenda that are included in the Bid Proposal. If Addenda are issued, the final Addendum will be posted no later than the end of the day two working days prior to the bid date. Each Addendum number and date must be entered on the submitted Certification Form.

102.04 Interpretation of Quantities in the 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 performed 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. Examine the site of the proposed Work, the Bid Proposal, and all Items designated in the Bid Proposal before submitting a Proposal. The Bidder

assumes responsibility for all site conditions that should have been discovered had a reasonable site investigation been performed, whether or not the Bidder actually performed the investigation. 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. The information is 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 such information is not intended as a substitute for the personal investigation, interpretations, and judgment of the Bidders.

The Department will not be bound by any statements or representations concerning site 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.

Submit any request for explanation of the meaning or interpretation of the Bid Proposal or Items designated in the Bid Proposal in writing to the Department's e-mail address listed in the Bid Proposal no less than six business Days prior to the Proposal opening date. Interpretations or explanations made by the Department in response to questions asked by prospective Bidders will be dated and posted periodically on Delaware's Bid Solicitation Directory Website. The final questions and answers document will be posted on the Website no later than the end of the day two business Days prior to the bid date. The final posted date must be entered on the submitted Certification Form. All questions and answers posted by the Department on the Website are included in the Contract by reference and become part of the Bid Proposal. The Bidder to whom the Contract is Awarded will receive a hard copy of the final posted questions and answers.

102.06 Preparation of the Proposal. Submit the Proposal either upon the Bid Proposal Forms, or upon approved electronic media as directed by the Contract Documents. When using approved electronic media to submit bids, provide both the electronic copy and a hard copy of the bid unless otherwise directed by the Proposal. Detach the Bid Proposal Forms 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 or electronically printed 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. Type or print the figures onto the form. In case of a discrepancy between the typewritten Unit Prices and the typewritten or electronically printed bid amount, the Department will use the typewritten or electronically printed Unit Prices. In case of a discrepancy between the Unit Prices contained on the approved electronic media and the Unit Prices on the hard copy generated by the electronic medium, the Department will use the hard copy Unit Prices.

Execute last minute handwritten substitutions of the typewritten or electronically printed Unit Prices on the typewritten Bid Proposal Forms or hard copy generated by the approved electronic media by striking a single line through the figure being substituted and legibly writing the new Unit Price in ink. Initial each last minute substitution. Legibility of the substitution will be solely determined by the Department.

Acknowledge all Department Addenda to the Bid Proposal, including questions and answers, in the certification form provided by the Department and submit the form with the modified Bid Proposal Forms. The Proposal submitted must be signed in ink by a representative of the Bidder authorized to execute Proposals. Provide the name and address of the individual signing the Proposal 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, corporate name, and corporate address

Bid Proposals, Bid Proposal Forms and approved electronic 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 will be considered irregular and will 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, interlineations, 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.
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. 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.
H. The Bidder fails to provide a Proposal Guaranty.
I. The Bidder fails to sign the non-collusive bidding certification.
J. The Proposal fails to comply with any other material requirements of the Invitation for Bids.
K. A bid will be held to be non-Responsive and not considered if specific DBE information is not provided at the time of bid: failure to present written and notarized assurance that the goals on the Contract will be met or failure to include Good Faith Effort Documentation in place of assurance; or, failure to present written copies of all DBE subcontracts within the prescribed number of 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 Department will provide a Bond form that complies with the requirements of 29 Del.Code Sec. 6962(d)(8)(a). The sum of the Proposal Guaranty must be equal to at least 10 percent 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 percent of the bid to which it relates and not to exceed a certain stated sum, if said sum is equal to at least 10 percent of the bid. "Securities" include certified checks, cashier's checks, treasurer's check, and other negotiable or transferable instruments evidencing an unconditional debt to the State or Department.

102.09 Delivery of the Proposal. Place the Proposal in a sealed envelope and plainly mark the envelope to indicate its contents, including the Contract designation and the name and address of the Bidder. Deliver Proposals prior to the time and to the place specified in the Advertisement. The Bidder bears the risk of delays in delivery. Proposals received after the specified time will be returned to the Bidder unopened. Proposals must be delivered to:

Contract Administration
DelDOT Administration Building
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 the opening of the Proposal by the Department.

102.12 Disqualification of Bidders. The Department may disqualify a Bidder and reject future submissions of Proposals from that Bidder until the Bidder is reinstated as a registered Bidder for the following reasons:

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), or failure to sign a Contract final Change Order for a completed Contract.

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, or within 30 Calendar Days following the resolution of any Contract Claims, whichever is later.

102.13 Rejection of Proposal. The Department may reject a Proposal for any of the following reasons:

A. The bidder has submitted more than one Proposal for the same Work from an individual, firm, or corporation under the same or different name.
B. Participants have colluded with other Bidders.
C. Work by the Bidder remains uncompleted which, in the judgment of the Department, might hinder or prevent the timely Completion of further Work if Awarded.
D. Failure of a Bidder 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 a Non-Collusive Bidding Certification subscribed to and affirmed by the Bidder as true under the penalties of Law. Sign the certification, and submit with the Bid Documents.

A Bid Proposal will not be considered for Award nor will any Award be made without a valid certification as provided above.

If the Bidder cannot make the foregoing certification, furnish with the Proposal a signed statement which sets forth in detail the reasons why the certification cannot be made. Where the Bidder has not complied with the provisions of the certification, the Department will neither consider the Proposal for Award nor Award the Proposal 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 the certification above.

SECTION 103 – AWARD AND EXECUTION OF THE CONTRACT; ESCROW BID DOCUMENTATION

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 Prices govern. The Department reserves the right to reject Proposals, waive technicalities, proceed to perform the Work otherwise, or advertise for new Proposals. Unit Bid Prices may also be affected by maximum price provisions noted elsewhere in the Contract Documents. In such cases, upon discovery of a discrepancy, the Department will adjust the Unit Bid Price to conform to the maximum permissible Bid Price.

103.02 Award of the 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 by letter or electronic means 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 an Award. The Department reserves the right to cancel the Award of any Contract before execution without liability.

103.04 Return of the 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 the satisfactory Contract Performance and Payment Bond has been furnished and the Contract has been executed. A Contractor will not be released from the obligations to provide a satisfactory Performance Bond and execute the Contract 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, furnish a Surety Bond or Bonds in a sum equal to 100 percent 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. Have the Bond issued by a corporate Surety authorized to do business in this State.

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. Present this form 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, and of all sums of money due the furnish or for such labor, services, or Material. The Bond shall also contain the successful Bidder's guarantee to indemnify and save harmless the State, the Department and the Department’s employees from all costs, damages, and expenses growing out of or by reason of the successful Bidder's failure to comply with applicable laws and regulations and failure to perform the Work and complete the Contract in accordance with the terms and conditions of 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 will be provided by the Department. The Surety must also be acceptable to the Department.

103.06 Withdrawal of a 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 its bid, put the request in writing to the Department's representative stating its 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 re-advertise for new Proposals.

103.07 Execution and Approval of the Contract; Proof of Insurance. 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 or liability. The Contract will not be considered effective until it has been fully executed by all parties to the Contract.

If the successful Bidder is a non-resident corporation, provide proof of compliance with the requirements of Subchapter XVI of Title 8 of the Delaware Code, and as further amended at the time of bid.

Maintain insurance in compliance with the requirements of Sections 2502 and 2503, Title 18 of the Delaware Code. Provide a certificate of insurance to the Department prior to the Execution of the Contract. If the Contract requires the Contractor to provide coverage for additional insureds, provide proof of additional insureds. The Department will not execute the Contract until an acceptable proof of insurance is provided.

103.08 Failure to Execute a Contract. Failure by the successful Bidder to execute the Contract and file an acceptable Bond within 20 Days after the Notice of Award will be considered a revocation of the Notice of Award and a forfeiture of the Proposal Guaranty to the Department. Contract Award may then be made to the next lowest Responsible and Responsive Bidder or the Work may be re-Advertised.

103.09 Escrow of Bid Documentation. If required by the General Notices, Special Provisions, or other language in the Bid Proposal that is specific to a particular Contract, submit to the Department legible copies of the Bid Documentation as set forth in this Section.

A. *Scope and Purpose*. The purpose of escrowing Bid Documents is to preserve all of the Contractor's Bid Documents for joint use by the Contractor and the Engineer in the resolution of any disputes, Claims, arbitration proceeding, litigation or negotiation arising from this Contract.

B. *Submittal, Escrow and Return of Bid Documentation*. Prior to the execution of the Contract, submit the Bid Documentation in a sealed container to the Department. Clearly mark the container "Bid Documentation" and show on the face of the container the Contractor's name, address, date of submittal, the Contract number and the Project designation. The Department and the Contractor will jointly deliver the sealed container and an affidavit per Section C. below 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 escrowed Bid Documents will remain in escrow subject to the terms of this Section until all of the following have occurred:

    1. One hundred eighty Days have elapsed from Final Acceptance;
    2. All disputes between the Department and the Contractor arising from or related to this Contract have been settled or resolved; and
    3. Final payment is made by the Department and accepted by the Contractor.

C. *Affidavit*. Submit an affidavit on a form provided by the Department, 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. 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 the Proposal for the Project, and (3) all such Bid Documentation is included in the sealed container submitted to the

Department. Include the signed affidavit with the sealed container submitted to the Department per Section B.

D. *Representation of Accuracy by the Contractor*. The Contractor represents and warrants that the escrowed Bid Documents provided with the Proposal constitute all of the information used in the preparation of its Proposal and agrees that no other Proposal preparation information will be considered in resolving disputes or Claims. The Contractor also agrees that the escrowed Bid Documents are not part of the Contract and that nothing in the escrowed Bid Documents shall change or modify the Contract.

E. *Contents and Form of the Escrowed Documents*. Clearly itemize in the escrowed Bid Documents the estimated costs of performing each aspect of the Work required by the Contract Documents. Separate all Work into sub-items as required to present a complete and detailed estimate of all costs. Detail all crews, Equipment, quantities and rates of production. Further divide estimates of costs into the Contractor's usual cost categories such as direct labor, repair labor, Equipment ownership and operation, expendable Material, permanent Material, and subcontract costs. Clearly identify allocations of plant and Equipment, indirect costs, contingencies, markup, and other items to each direct cost item. Include all assumptions, quantity takeoffs, rates of production and progress calculations, quotes from Subcontractors and suppliers, memoranda, narratives and all other information used by the Contractor to arrive at the Bid Price for the Contract.

Submit the escrowed Bid Documents in the format actually used by the Contractor in preparing the Proposal. The Department does not intend for the Contractor to perform any extraordinary Work in the preparation of these documents prior to the Proposal due date. However, the Contractor represents and warrants that the escrowed Bid Documents related to the Proposal have been personally examined prior to delivery to escrow by an authorized officer of the Contractor and that such documents meet the requirements of this Section.

F. *Changes to the Contract*. The Department may require all documentary information used in preparation of the quotation of prices for Additional or Extra Work performed on the Contract. If required, the Engineer will request the documents in writing and the Contractor and Engineer will place the additional documents in the sealed container held in escrow. Documents supporting new prices will be subject to all of the requirements of this Specification.

G. *Availability for Review*. The escrowed Bid Documents shall be available for joint review by the Department and the Contractor for the resolution of disputes and the negotiations of changes to the Contract. The Department will be entitled to review all or any part of the escrowed Bid Documents in order to determine the applicability of the individual documents to the matter at issue. The Department will be entitled to make and retain copies of such documents as it deems appropriate in connection with any such matters, provided that the Department has executed and delivered to the Contractor a confidentiality agreement specifying that all proprietary information contained in such documents will be kept confidential; that copies of such documents will not be distributed to any third parties other than the Department's agents, attorneys, auditors, and experts who are aiding the Department in resolving the issue at hand; and that all documents and copies of documents will be returned to the depository upon resolution of the issue. 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. The foregoing shall in no way be deemed a limitation on the Department's discovery rights with respect to such documents.

H. *Confidentiality of Bid Documentation*. The escrowed Bid documents are and shall always remain the property of the Contractor subject to the Department's right to review them as provided herein. The Department acknowledges that the Contractor may consider that the escrowed Bid Documents constitute trade secrets or proprietary information. The Department further acknowledges that the Contractor expended money in developing the information included in the escrowed Bid Documents and that it would be difficult for a competitor to replicate the information contained therein. The Department acknowledges that the escrowed Bid Documents and the information contained therein are being provided to the Department only because it is an express prerequisite to execute this Contract. Thus, the escrowed Bid Documents will at all times be treated as proprietary and confidential information and will be used only for the purposes described herein. At the Contractor's request, confidentiality agreements will be executed and delivered to the Contractor by the Department's employees or agents who review or have access to the escrowed Bid Documents.

I. *Refusal or Failure to Provide Bid Documentation and Review by the Department*. Failure to provide Bid Documentation will render the Proposal non-Responsive and the Contractor shall forfeit the Proposal Guaranty in accordance with Section 103.08. The Department may, at any time, conduct a review of the escrowed Bid Documents to determine whether they are complete. In the event the Department determines that any data is missing, provide such data within three Working Days of the request and at that time it will be date stamped, labeled to identify it as supplementary material, and added to the escrowed Bid Documents. The Contractor shall have no right to add documents to the escrowed Bid Documents except upon the Department's request.

J. *Cost and Escrow Instructions*. The costs for complying with this Section are incidental to the Contract. 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 Section.

SECTION 104 – THE CONTRACTOR'S RESPONSIBILITY FOR THE WORK; CHANGES TO THE CONTRACT; SUSPENSION OF WORK; THE USE OF BRIDGES DURING CONSTRUCTION

104.01 Intent of the Contract. Cooperate with the Engineer to complete the Work described in a manner that is safe and poses the least practicable impact to the flow of vehicular and pedestrian traffic. Furnish all labor, Materials, Equipment, tools, transportation, and supplies required to complete the Work in accordance with the Contract. Perform all alterations to the Contract or requests for Extra Work from the Engineer in accordance with the terms of the Contract.

104.02 Existing Signs. Inventory all existing signs (i.e., Traffic, Bus Stops, Street Names, etc.) within the limits of the Contract with the Engineer prior to commencing the Work. Maintain necessary traffic signs as directed by the Engineer during construction, and properly store all other signs. Return all stored signs to the Engineer at the end of the Project. The Contractor is responsible for any loss of, or damage to, stored signs throughout the duration of the Project.

104.03 Bus Stops. Maintain bus stops as prescribed in Section 801.

104.04 Material Testing Notification. For Portland Cement Concrete and Bituminous Concrete material testing, the Contractor must notify the Materials & Research Section of the quantity and time of the scheduled release by 3:00 P.M. the business day prior.

No Portland Cement Concrete or Bituminous Concrete materials shall be shipped to the job without first being released by the DelDOT Inspector. When DelDOT releases materials for shipment, DelDOT does not guaranty that the materials meet the specifications or are suitable for use. The Contractor is solely responsible for the suitability of the materials shipped. DelDOT may waive the release requirements on a case by case basis. Waivers of releases by DelDOT do not waive the release requirements for future shipments.

104.05 Accident Notification. Immediately notify DelDOT's Transportation Management Center (TMC) at 302-659-4600 and the Engineer's site representative of any incidents resulting in damage to property or personal injury occurring within the limits of the Project.

104.06 Contract Revisions, Changes in the Character of the Work and Major and Minor Items. The Department reserves the right at any time prior to the Completion of the Contract to issue plan revisions, make adjustments in Contract Item quantities, or make such other alterations considered necessary to satisfactorily complete the Contract. Perform the revised Work immediately upon receiving direction from the Engineer to do so. The Engineer will pay for the revised Work at the Contract Unit Prices unless the revision results in a change to the character of the Work as defined below. In the case of a change to the character of the Work, the Engineer may

revise the Contract as specified in Section 109.04. If the determination that the character of the Work has changed is based solely upon Section 104.06.A.2, the change to the Unit Price applies only to that portion in excess of 125 percent of the original Contract Quantity, or in the case of a decrease below 75 percent, to the actual amount of Work performed under the Item.

Payment for Contract revisions or changes in the character of the Work will exclude any amount for loss of anticipated profits alleged to result from the change. Changes to the Contract do not invalidate the Contract or release the Contract Surety. If, as a result of such changes, the Contractor requires additional time to complete the Work, request an extension of Contract Time. The Engineer will evaluate such a request and will grant an extension of Contract Time if the request is justifiable in accordance with Section 108.07. All Contract revisions will be issued in writing by the Engineer.

A. If the Engineer alters Contract quantities, the Work, or both as necessary to satisfactorily complete the Project, such an alteration changes the character of the Work if:

    1. The alteration requires the Contractor's means and methods in performing the Work to differ materially in kind or nature from that involved or included in the original Contract; or

    2. The alteration causes the quantity of a Major Item, as defined in Section 101.03, to increase in excess of 125 percent or decrease below 75 percent of the original Contract Quantity.

104.07 Differing Site Conditions. If Differing Site Conditions, as defined by Section 101.03, are encountered at the Project site, promptly notify the Engineer as specified in Section 104.09. Stop Work in the affected area and preserve the evidence of the alleged Differing Site Conditions so that the Engineer can investigate whether the conditions differ materially from those that the Contractor reasonably should have expected as defined in Section 101.03. Do not proceed with the Work in the affected area until the Engineer provides written notification to continue.

If the Engineer determines that the conditions differ materially from those that the Contractor should have reasonably expected as defined by Section 101.03, and such Differing Site Conditions caused an increase or decrease in the cost or time required for the Contractor to perform the Work, a written Adjustment will be made to the Contract by the Engineer. Adjustments in the Contract price for Differing Site Conditions will be made under Section 109.04, and Adjustments in Contract Time for Differing Site Conditions will be made under Section 108.07. No Adjustments in Contract Price will include loss of anticipated profits. 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 Section 104.09 and has afforded the Engineer an opportunity to investigate the alleged Differing Site Conditions before further disturbing the affected area.

104.08 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 that would be in the best interest of the Department. Immediately comply with the written order of the Engineer to suspend the Work.

If the delay resulting from the written suspension order is unreasonable, submit a written request for a Contract Adjustment to the Engineer within seven Calendar Days of the Engineer's order to resume Work providing the reasons and justification for the Adjustment. If:

A. An increase in the Contract performance cost or time results from an unreasonable delay caused by the suspension; and

B. 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, then:

Adjustments in the Contract price, excluding profit, will be made according to Section 109.04 and Adjustments to Contract Time will be made according to Section 108.07. The Engineer will not adjust the Contract Time or price if the Work performance would have been suspended or delayed by any other cause under any other terms or

conditions of the Contract or if the Contractor fails to submit a request for an Adjustment to the Contract within the allowable time prescribed above.

The Engineer may suspend the Work when the Contractor fails to perform any provisions of the Contract. In such a case, the Engineer will neither adjust the Contract Time nor price nor will the Engineer pay for traffic control devices or maintenance of traffic during the suspension period. The Engineer will order the Work to resume when conditions are favorable as determined by the Engineer.

104.09 Notification Requirements for Differing Site Conditions, Changes in the Character of the Work and Extra Work. 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; any delay that is compensable under the terms and conditions of the Contract; and/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, provide the following 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. The name, title, and activity of each Department representative knowledgeable of the alleged change.

3. Copies or descriptions of any documents and the substance of any oral communications involved in the alleged change and the basis for an allegation of accelerated Schedule performance, if applicable.

4. The basis for an allegation that the Work is not required by the Contract, if applicable.

5. The 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. Materials that were/will be added, deleted, or wasted by the alleged change and a list of Equipment that was/will be idled or required by the alleged change.

c. Labor that was/will be forced to remain idle on the jobsite as a result of the alleged change.

d. Delay and disruption to the manner and sequence of performance that has been or will be caused by the alleged change.

e. Estimated Adjustments to Contract price(s), delivery schedule(s), staging, and Contract Time necessary due to the alleged change.

f. 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 Section 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; or

2. Deny that a change occurred and, when necessary, direct the method and manner of further performance; or

3. Advise the Contractor that additional time is required to evaluate the allegation or that 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 will not include increased costs or time extensions for delays resulting from the Contractor's failure to provide requested additional information in accordance with this Section.

104.10 Maintaining Traffic. Keep all roads, driveways, entrances, sidewalks, trails and paths open to all vehicular, bicycle and pedestrian traffic during the construction unless otherwise specified in the Contract Documents. Submit a temporary traffic control plan for the Work at the preconstruction meeting. All temporary traffic control and temporary traffic control devices shall comply with the Contract Documents and with the latest edition of the Delaware Manual on Uniform Traffic Control Devices (MUTCD), including all revisions as of the date of the Advertisement of the Contract. The MUTCD is available for download at www.mutcd.deldot.gov.

104.11 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.

Replace the removed Material if necessary with acceptable Material at no cost to the Department. Do not excavate or remove any Material that is not within grading limits without written authorization from the Engineer.

104.12 Additional Utility Relocations Required by the Department; 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. Allow parties bearing such permits and only those parties, to make openings in the highway. When ordered, 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.

104.13 Value Engineering Proposals by the Contractor. A Contractor may submit a request to modify the Contract Documents for the purpose of reducing the total cost and/or duration of Construction without reducing design capacity or the quality of the finished product. This request is called a Value Engineering Proposal (VEP). Any cost savings generated to the Contract as a result of a VEP offered by the Contractor and approved by the Department will be shared by the Contractor and the Department on a 50-50 basis. The purpose of a VEP is to encourage the use of the Contractor’s ingenuity and experience in recommending approaches and methods differing from existing Contract Specifications that will reduce the overall cost and/or time of the Project.

Do not base Bid Prices on the anticipated approval of a VEP. If a VEP is rejected, complete the Work at the original 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 effect 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, remain obligated to the terms and conditions of the existing Contract.

A. **General Requirements.** The Department will only consider VEP’s that could produce a savings in cost and/or time 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 a VEP.** Submit the following materials and information with each VEP:

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

1. The VEP, whether approved or not approved by the Department, applies only to the ongoing Contract(s) referenced in the VEP and becomes the property of the Department. Include no restrictions imposed by the Contractor on the use or disclosure of the VEP or information within the VEP by the Department. 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. 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 for any reason, including, but not limited to, that the VEP requires excessive time or costs to review, evaluate, or investigate, or that the VEP 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 VEP, or for its removal. Where modifications to the VEP are approved to adjust to field conditions or other conditions, reimbursement will be limited to the total amount payable for the Work at the Contract Unit Bid Prices as if it were constructed under the original Contract requirements or, in the case of a time-only VEP, the total amount of the VEP. The rejection of unsatisfactory VEP Work or limitation of reimbursement for such Work shall not constitute the basis of any Claim against the Department for delays, delay costs, or for any other costs. Any changed conditions arising as a result of the acceptance of a VEP will not be considered as the basis for any Claim for additional compensation.

6. Propose no Work containing experimental features; propose only proven features that have been used under similar or acceptable conditions on other projects or locations acceptable to the Department.

7. A VEP will not be considered if equivalent options are already provided in the Contract. The VEP must be sufficient to warrant a review and processing.

8. A VEP proposing to change the type or thickness of the Pavement Structure will not be considered.

9. 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 percent 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 Unit Bid Prices. If the VEP provides only a savings in time to the Department, there will be no sharing of savings between the Department and the Contractor.

3. The Contractor's costs for development, design, and implementation of the VEP are not eligible for reimbursement.

4. The Contractor may submit a VEP for an approved Subcontractor. Subcontractors may not submit a VEP except through the Contractor.

104.14 Final Cleaning of Project Site; Maintenance and Cleanup of Staging Areas. Before the Final Inspection of the Project, clean all rubbish, excess Materials, temporary Structures and Equipment from the Project, any publicly owned borrow source used to complete the Work, and all areas affected by the Contractor in connection with the Work within the Right-Of-Way. Trim all surfaces and slopes, whether old or new, to the cross-section. Cut all grass and weeds that are taller than 6 inches, and leave all parts of the Work in an acceptable condition. The cost of the final cleanup is incidental to the Contract and no separate payment will be made.

Install erosion and sediment control measures that comply with stormwater regulations for all staging areas to the satisfaction of the Engineer. Restore all areas used for staging operations upon Completion of the Work. Restore paved staging areas to their original condition. Restore unpaved staging areas by re-grading and placing topsoil, seed and mulch to the satisfaction of the Engineer. Perform all restoration Work in accordance with Sections 202 and 908 of these Standard Specifications. All costs associated with restoration of staging areas and establishing an acceptable stand of grass are incidental to the Contract.

104.15 Contractor's Responsibility for the Work. Retain sole and absolute responsibility for the Work and provide for the protection and safety of all agents and employees of state and federal agencies, Contractors, Subcontractors, suppliers, and members of the general public until Substantial Completion is achieved as defined in Section 101.03. 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 and/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 Section 109.04. "Items not under the control of the Contractor" shall be defined for purposes of this Section 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, maintain responsibility for the Project and take such precautions as may be necessary to prevent damage to the Project, provide for normal drainage and normal traffic operations, and erect any necessary temporary Bridges, signs, or other facilities. During such period of suspension of Work, properly and continuously maintain in an acceptable growing condition all living Material in newly established plantings,

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

104.16 Required Notifications for Disturbing Property and using Bridges. Give two weeks' notice to property owners when any fixture, shrub, or other object must be removed from a Right-Of-Way or easement area. If the owner does not attempt to salvage this property within the two week period, remove it without further obligation.

Before starting any Work that will change the loadings on an existing or proposed Bridge, inform the Engineer of the proposed loadings (axle spacing, axial loads, stockpiling and Equipment locations) including quantity of and type of construction Equipment and vehicles proposed for use. The loading that the Contractor's Equipment will apply to the Bridge will 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 the Specifications. If at any time the Contractor's upcoming operations would result in a change to the loading and / or the location of the loading on a Bridge, submit the proposed loadings for approval by the Engineer prior to changing the loading. Perform no Work that will change the loadings on any Bridge within the Contract limits until the Engineer's approval has been obtained. Review time will be in accordance with Section 105.04.

SECTION 105 – RESPONSIBILITIES OF THE DEPARTMENT; INTERPRETATION OF THE CONTRACT DOCUMENTS; MAINTENANCE DURING CONSTRUCTION; CLAIMS; PROJECT ACCEPTANCE

105.01 Authority of the Engineer. The Engineer is the administrator of the Contract and not a supervisor of the Work. Perform all Work to the satisfaction of the Engineer, but maintain 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 will 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 Section 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 performed and all Material furnished by the Contractor. 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 will 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 will in no case act as foreman or perform other duties for the Contractor, nor interfere with the management of the Work by the Contractor. 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.

The Engineer may issue a written order to the Contractor to stop Work giving the reason for shutting down the Work. After placing the order in the hands of the Contractor's representative in charge at the Project Site or sending an electronic copy of such an order to a responsible party in the Contractor's organization, the Inspector will immediately leave the job, and in such cases Work performed by the Contractor during the absence of the Inspector will not be paid for and may not be accepted. The Engineer will identify the person(s) within the Department who have the authority to issue a Stop Work order at the preconstruction meeting for the Contract.

105.03 Inspection of the Work. Allow the Engineer access to all parts of the Work at all times for inspection. Furnish information and assist the Engineer as required to make complete and detailed inspections. Inspection may include mill, plant, or shop inspection; and/or any Material furnished under these Specifications. If the Engineer fails to reject defective Work or Materials, whether from lack of discovery of such defect or for any other reason, such initial failure to reject in no way prevents the later rejection of the Materials or Work when such defect is discovered, or obligates the Engineer to Final Acceptance. The Engineer is not responsible for losses suffered by the Contractor due to removals or repairs of such defects.

Remove or uncover portions of the finished Work as directed at any time before acceptance of the Work. After examination, restore those portions of the Work to the standard required by the Contract. If the exposed Work proves to be acceptable, the uncovering or removal and restoration will be paid as Extra Work. If the exposed Work proves to be unacceptable, the uncovering or removal and restoration shall be at the Contractor's expense.

Any Work performed 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, utility company, or any railroad corporation pays a portion of the cost of the Work performed on this Contract, its respective representatives have the right to inspect the Work. Such inspection shall not make any unit of government or political subdivision, utility company, 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. The Department will furnish, with the Bid Proposal, Plans of sufficient detail to convey a comprehensive understanding of the Work specified. Furnish Working Drawings as required by the Engineer. Do not incorporate any changes from the requirements of the Contract in the Working Drawings unless the changes are specifically denoted, together with justification, and 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. Identify Working Drawings and submittals by the Contract number. Identify Items or component Materials by the specific Contract Item Number and Specification reference in the Contract.

Any staging and stockpile area(s) outside the Project's LOC that individually or cumulatively are larger than 10,000 square feet must be approved by DelDOT's Archaeologist. Submit all staging and stockpile areas outside the Project's LOC for approval. Within 30 Days, DelDOT will:

A. Approve the use of the proposed staging and stockpile area(s),
B. Reject the request, or
C. Perform an archaeological survey to determine whether to approve or reject the request, which my take up to 3 months.

If an archaeological survey is necessary, DelDOT or a consultant on its behalf will undertake the survey.

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.

Provide such details on Working Drawings as are required for successful prosecution of the Work. Include plans for Items such as Falsework, bracing, sheeting, shoring, cofferdams, Formwork, masonry layout diagrams, and bending diagrams for reinforcing steel.

Submit copies of the manufacturer's catalog cuts, drawings, wiring diagrams, etc. with Working Drawings for electrical and mechanical Equipment. After all Items of a particular system have been reviewed, prepare an

"Instruction Book" especially for the system. Include in the "Instruction Book" 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. Also include in the book a recommended spare parts list, renewal parts bulletins, and instruction bulletins for the Equipment furnished. Use diagrams and drawings of reduced size suitable for binding. Include a proper index listing all Items. Properly fasten and bind in a suitable leather or heavy plastic cover book with a title clearly shown.

Prior to Final Inspection, supply five copies of the book to the 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.

Submit electronic copies of Working Drawings to the Engineer following the procedure set forth in Figure below, unless otherwise defined at the preconstruction meeting. Should any questions arise as to the proper procedure for submitting Working Drawings, contact the Engineer for clarification. 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, incorporate the comments and do not resubmit the drawings. If the Contractor does not agree with the comments, state the reason for disagreeing with the comments in writing and submit the reasons to the Department within ten Working Days after receipt of the Department's comments.

The Department does not review every detail of every Working Drawing or other submittal made by the Contractor. Consequently, 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 to the requirements of the Contract.

Reviewed Working Drawings, submittals, or resubmittals will be transmitted to the Contractor within forty-five (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 sixty (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 Section 108.07 will be considered.

The Department generally follows the submittal flowchart provided on the following page in reviewing and approving Working Drawings.

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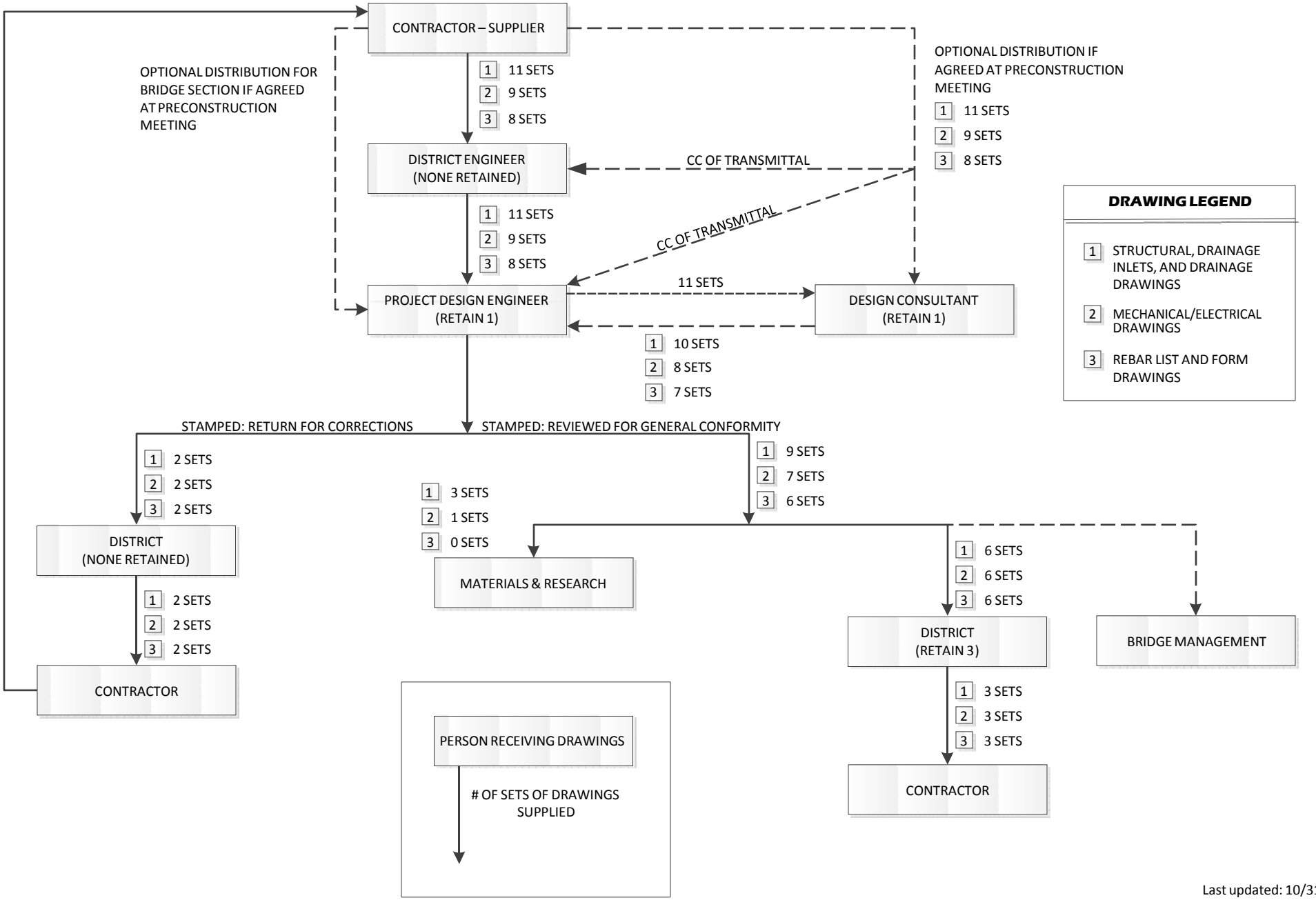
WORKING DRAWING SUBMITTAL PROCESS



Last updated: 10/31/2014

105.05 Conformity with the Plans and Specifications. Perform all Work and furnish all Materials 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.

If the Engineer finds that 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 will 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 by the Engineer.

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, remove and replace or otherwise correct the Work or Materials at the expense of the Contractor. If provisions are included in the Contract for the acceptance of Materials or Work that are not in full compliance with the minimum requirements stated, adjust the pay per those provisions.

105.06 Coordination of the Contract Documents; Duty to Report Errors to the Engineer; Use of Dimensions over Scaled Measurements. Each individual Contract Document is an essential part of the Contract and a requirement occurring in one is binding as though occurring in all. All of the Contract Documents are intended to be complementary and to describe and provide for a complete Contract. In the case of a discrepancy between the Contract Documents the governing ranking will be:

A. General Description

B. General Notices

C. Plans

D. Special Provisions

E. Standard Construction Details

F. Standard Specifications

Do not take advantage of any apparent error or omission in the Contract. If the Contractor discovers an error or omission, promptly notify the Engineer. The Engineer will make corrections and interpretations as necessary to fulfill the intent of the Contract. Do not use scaled measurements when the dimensions on the Plans are given or can be computed from the information given.

The Contractor is responsible to verify during construction that the conditions actually encountered are consistent with the design and related Contract Documents during the course of construction. Issue a written Request For Information (RFI) to the Engineer for clarification and response, if any questions arise, experience interference / conflict caused by design, or feel errors and omissions may exist in the Contract Documents. The Engineer will respond to each RFI in writing clearly indicating all applicable design revisions. Provide a copy of all RFIs and responses to the Department as they are issued.

If a deviation from the specified sampling or testing procedures and/or Contract Documents is identified by the Contractor, Inspector or any representative thereof, then submit for approval a written Non-Conformance Report (NCR), including its associated corrective actions forward, covering such deviation. Include in the NCR, description of construction activity and location by Specification.

Make every attempt to identify issues and deviations from the Contract Documents in advance of the Work in order to allow the Department three (3) Working Days from receipt of the written notice to review and respond accordingly to any RFI and NCR. The Department will work with the Contractor with response to any RFI or NCR that requires immediate attention.

105.07 Copies of the Plans; Contractor's Supervision. The Contractor will be supplied with two copies of the Plans and the Bid Proposal. Keep one copy at the Project site at all times. Give the Work the constant attention necessary to facilitate progress and cooperate with the Engineer in every way possible.

Furnish (a) a competent Superintendent or supervisor who is employed by the firm, has full authority to direct performance of the Work in accordance with the Contract requirements, and is in charge of all construction operations, regardless of who performs the Work and (b) such other organizational resources, including supervision, management and engineering services, as the Engineer determines is necessary to assure the performance of the Contract. The Superintendent or supervisor must be present on site while Work is being performed and must be competent, capable of reading and understanding the Contract and experienced in the type of Work being performed. The Superintendent or supervisor is the point of contact for the Engineer, authorized to act for the Contractor, and has 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.

Contractors performing work on the same Project shall 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, conduct the Work without interfering or hindering the progress or Completion of the Work by other Contractors.

Each Contractor involved assumes all liability, financial or otherwise, in connection with its respective Contract. 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.

Coordinate and sequence the Work with other contractors. Arrange, place, and dispose of Materials without interfering with the operations of other contractors on the same Project.

105.09 Utilities within the Project Limits; Miss Utility One-Calls. Bidders are hereby notified that within the limits of the Work under this Contract, several utility facilities and/or appurtenances may be encountered. The locations of all utilities shown on the Plans or mentioned in the Contract Documents are approximate locations only.

Prior to Advertisement, the Department will notify all utility companies, pipeline owners, railroads, or other parties known to be affected by the Work, and endeavor to have all necessary relocations 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, do not proceed with the Work before conferring 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, do not begin any construction around or adjacent to utilities without notifying the Utilities Service Protection (Miss Utility) of Delmarva, Inc. at least two Working Days, but not more than ten Working Days in advance of starting the Work. 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.

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 in the Contract. Allow utility contractors performing Work within the limits of the Contract to use the Contractor's maintenance of traffic (MOT) devices that are already in place as a result of the Work, such as "Road Work Ahead" signs and MOT related to the Project's construction phasing. The respective utility contractor is responsible for their own Equipment, Work and personnel safety while working within the limits of another Contractor. Utility contractors performing Work within the work zone shall use their own MOT devices at their own expense for daily construction activities such as lane and shoulder closures. Utility contractors shall provide their own flaggers. The Engineer reserves the right to order the Contractor to provide MOT for utility companies working within the work zone. When the Engineer issues such an order, the Engineer will pay for the work under the Unit Prices in the Contract. If Unit Prices for MOT ordered by the Engineer do not exist on the Contract, the Contractor and the Engineer shall negotiate a new price for the work or follow the Force Account procedure for reimbursement. If the Contractor provides MOT at the request of a

utility company, the Engineer will not make payments under the Contract. The utility company will pay the Contractor.

The Engineer will not pay for any relocation or rearrangement of utility facilities or appurtenances made for the Contractor's sole convenience.

Consider in the bid all the permanent and temporary utility appurtenances in their present or relocated positions as shown on the Plans or as readily discernible. No additional compensation will be allowed for any delays, inconvenience, or damage due to any interference from such utility facilities and appurtenances or the operation of moving them, except that the Contractor may be granted an extension of Contract Time.

The relocation of existing utilities that will interfere with the proposed construction, the construction of new utility facilities, and/or the reconstruction of existing utility facilities 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. Repair such damage immediately.

Prior to performing any Work on the Project, 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.

The following Utilities are members of Utilities Service Protection Center of DELMARVA (USPCD):

24/7 Mid-Atlantic Network, LLC
AboveNet Communications
Aero Energy
AIRCO
Angola Crest, LLC
Artesian Water Company
AT&T of Delaware
Atlantic Broadband
Bethel Township Sewer Dept
Camden-Wyoming Sewer & Water
Cavalier Telephone
Chesapeake Utilities
Choptank Electric
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 Pocomke
City of Rehoboth Beach
City of Seaford
City of Wilmington
Colonial Pipeline Co.
Columbia Gas Transmission
Comcast Cable Communications
Connexion Technologies
County Propane of Delaware
Dept.of Transportation
Delaware Electric Cooperative
Delaware Pipeline Company
Delaware State Highway
Delaware Storage and Pipeline Com
MCI
Mediacom of Lower MD/DE
Moore Grant Sanitation
Municipal Utility Commission
Neon Optica, Inc
New Castle County Special
ServicesNUI Elkton Gas
Paradee Gas Co.
Pep-Up, Inc.
Peninsula Oil and Propane
P.F. Net Network Corporation
Poores Propane
Qwest Communications
Savannah’s Landing HOA
Schagrin Gas Company
Sharp Energy
Steeplechase Waterworks
Sunoco Pipeline, LP
Sussex County Engineering Dept.
Sussex Shores Water Co.
Texas Eastern Transmission, LP
Tidewater Utilities
Town of Bethany beach
Town of Blades
Town of Bridgeville
Town of Chesapeake City
Town of Clayton
Town of Dagsboro
Town of Felton
Town of Georgetown
Town of Laurel
Town of Middletown
Town of Millsboro
Town of Milton

Delmarva Power
Direct Propane
Eastern Shore Gas
Eastern Shore Natural Gas
Eastern Utilities Commission
G4S Technology, LLC
Gull Point Condominium Association
Kent County Public works (Engineering)
Kent County Sanitary District
Kitts Hummock Improvement Association
Level 3 Communications
Long Neck Water Co.
Magellan Midstream Partners, L.P.
Magellan Terminals Holding, LP
Town of Selbyville
Town of Smyrna
Tunnel Companies, Inc.
United Water
University of Delaware
Verizon Communications
Wastewater Utilities, Inc.
Williams Gas Transmission
W.L. Gore & Associates, Inc.
XO Communications
YMG Corporation

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 (10) Working Days advance notice of starting time is required. The Day of the call is not counted as one of these Days. 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. The ticket life is for ten (10) Working Days after the call.

Messages received are sent out immediately during normal work hours (7:00 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 it has 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.

APWA recommended safety color codes will be used: white for proposed excavation, pink for temporary survey marking, orange for communications, red for electric, blue for potable water, green for sewer and drain lines, yellow for gas and petroleum products, purple for reclaimed water. This will enable the reporting party to visually see if the utility has responded.

Overhead High-Voltage Line Safety requires notification to and mutually agreeable measures from the utility from any person intending to carry on any function, activity, Work or operation within 20 feet of any high voltage overhead line.

105.10 Construction Stakes, Lines, and Grades Provided by the Engineer. The Engineer will furnish and set control points and construction stakes unless otherwise specified in the Contract Documents.

The Engineer will establish Right-Of-Way lines, Limits of Construction, and easements if needed, and will provide and set construction stakes establishing Right-Of-Way lines, 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-sets to complete the Structure. Use these stakes and marks as the field control to establish other necessary controls and perform the Work. Before beginning the Work, 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.

Protect and preserve 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 Section. The Department will not be responsible for staking delays unless the Contractor provides the Engineer ten (10) Calendar Days' notice prior to beginning Work for which layout is needed and thereafter gives at least two (2) business days' notice that stakes are needed.

105.11 Removal of Defective and Unauthorized Work. All Work that fails to meet the Contract requirements will be deemed unacceptable by the Engineer. Remove and dispose of all unacceptable Work at the Contractor's expense immediately upon rejection by the Engineer. Work performed without adequate layout, Work performed beyond the lines and grades shown on the Plans, or any Extra Work performed without written direction by the Engineer will be considered unauthorized Work and will not be measured or paid by the Department. The Engineer may direct the Contractor to remove and replace unauthorized Work 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 from the Engineer shall be sufficient cause for the termination of the Contract. Furthermore, the Engineer will have the authority to cause unacceptable Work to be remedied or removed and replaced, and unauthorized Work to be removed. The costs incurred by the Engineer for correcting unacceptable or unauthorized Work will be deducted from the amount due or to become due the Contractor.

105.12 Load Restrictions. 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 that 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. The allowable GVW for the delivery truck must be shown on each material ticket submitted to the Engineer.

Payment for Materials delivered to the Project will 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.

Notify 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.

Assume responsibility for all damage caused by hauling Equipment, whether the damage occurs within or outside of the Project limits.

105.13 Maintenance during Construction. Maintain the Work during construction and until the Project is accepted. Perform this maintenance every Day in a continuous and effective manner with adequate Equipment and forces to keep the roadway and Structures in a satisfactory condition. All snow removal will be performed by DelDOT Maintenance, unless the Contract Documents specifically assign these responsibilities to the Contractor. All mowing of grass outside of the LOC will be performed by DelDOT Maintenance.

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 twenty-four (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. Failure to adequately and safely maintain the Project will be sufficient cause to terminate the Contract for default.

If the Contract involves the placement of Material on or the use of a previously constructed subgrade, base course, pavement or Structure, maintain the previously constructed Work during construction operations.

The cost of maintenance Work during construction and before the completion of the Final Inspection punchlist is incidental to the Contract. The cost of maintenance Work occurring after the Final Inspection punch list is complete will be paid by the Engineer, except that the cost of maintenance Work required for landscaping and vegetative growth shall be borne by the Contractor until Final Acceptance.

In the event that the Contractor's Work is ordered shut down for failure to comply with the provisions of the Contract, 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.

Mow all grass and weeds within the Limits of Construction, as directed by the Engineer, to a height in compliance with Section 107.01. If the Engineer directs the Contractor to mow grass more than 4 times in a calendar year, the Engineer will pay for all mowing beyond the fourth mowing operation.

105.14 Opening Sections of the Project to Traffic. The Engineer may order certain sections of the Work to be opened to traffic or other use prior to Completion or acceptance of the Work. Opening these sections will not constitute acceptance of the Work or waiver of any Contract provisions. For sections of the Work that are open to traffic, the cost of repairing damage to the Work caused by vehicular traffic will be paid by the Engineer unless such section of roadway is open due to the fault or inactivity of the Contractor or the Contractor caused the damage. All other maintenance costs including, but not limited to, mowing grass, general cleanup and/or the repair of Work damaged by vandalism are borne by the Contractor until the Final Inspection punch list is complete, except that maintenance costs for Work involving landscaping and vegetative growth that are borne by the Contractor until Final Acceptance. Prior to opening a section of the Work to traffic, confer with the Engineer to ensure that all traffic control devices are in place and functioning. Do not open any section of roadway to traffic without the approval of the Engineer.

105.15 Claims for Adjustments and Resolution of Disputes. All disputes between the Contractor and the Engineer arising under or related to this Contract that are not resolved by mutual agreement shall be resolved by following the Claim procedure established in this Section. "Claim" means a written demand or assertion by the Contractor or the Department seeking, as a legal or equitable right: payment of money, Adjustment or interpretation of Contract terms, or other relief.

A. ***Contractor Notification of Claims.***

Notify the Engineer orally or in writing of the intention to make a Claim for relief before beginning the affected Work. Within five Working Days of declaring the intention to make a Claim, provide written notification of the Claim to the Engineer that includes the following:

1. The date of the occurrence and the nature and circumstances of the occurrence that constitute a change to the Contract or the need for an interpretation of the Contract's terms;

2. The name and title of Department representatives knowledgeable of the conditions on which the Claim is based; and

3. The particular elements of Contract performance for which relief is sought under this Section.

When a Claim is based solely upon the need for a Contract interpretation, provide written notice of the intent to Claim as prescribed above within five (5) Working Days of the discovery by the Contractor of the alleged misinterpretation of the Contract by the Engineer.

If the Contractor's written notification is not given to the Engineer within five (5) Working Days as prescribed above or the Engineer is not afforded proper facilities by the Contractor for keeping strict account of the actual costs incurred by the Contractor as a result of the alleged change or alleged misinterpretation of the Contract, then the Contractor waives the Claim. 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 Section shall be construed as establishing any Claim contrary to the terms of Section 104.06 or any other provision of the Contract Documents.

B. ***Engineer's Response to the Contractor's Notice.***

Within ten (10) Calendar Days after receipt of the Contractor's written notice of a Claim, the Engineer will respond in writing to the Contractor to:

1. Confirm that a change has occurred and that relief is due as provided herein; or

2. Confirm that the Engineer agrees with the Contractor's interpretation of the Contract and that relief is due as provided herein; or

3. Deny that relief is due and direct the Contractor to follow the formal Claim submittal procedure as described below; or

4. Advise the Contractor that adequate information has not been submitted to decide whether B.1., B.2. or B.3. above applies, and indicate the need for more information for further review. The Department will respond to such additional information within ten (10) Calendar Days of receipt from the Contractor; or

5. Advise the Contractor that the Engineer will review the Claim after obtaining the formal Claim submittal as described below.

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

C. ***Claim Submittal.***

Submit a formal Claim in writing within sixty (60) Calendar Days after Work on the Item Claimed has been completed. The Contractor can only recover, and the formal Claim shall only consist of, those items allowed under Section 105.15.H. The formal Claim submittal must contain:

1. A description of 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 that relief 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.

When requesting a time extension or relief due to a constructive acceleration, include an as-built Project Schedule that conforms to the requirements of the Contract. Failure to submit such a Schedule constitutes a waiver of the Contractor's right to receive a time extension or other relief due to a delay or a constructive acceleration.

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In complying with the Claim submittal requirements listed above, 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 for all Claims. The Contractor further agrees that any claimed dollar amount and/or relief sought that is not made pursuant to this Section and within the time limits prescribed by this Section shall be forever waived and not raised at any subsequent meeting or hearing dealing with the Claim. The Department will establish a claims procedure to be followed that is consistent with these Specifications and provides the means and methods by which the Contractor and the Department shall process the Contractor's formal Claim.

D. ***District Review.***

Formal Claims submitted in accordance with this Section will be reviewed fully at the District level. Within thirty (30) Calendar Days after receiving the formal 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. Upon mutual agreement, the parties may engage in non-binding alternate dispute resolution proceedings in order to try and induce a settlement of the dispute prior to the District's decision. These proceedings may include, but are not limited to, non-binding arbitration or mediation.

E. ***Contractor's Appeal to the Claims Committee.***

The Contractor may appeal the District's decision to DelDOT's Claims Committee for review. Give notice of the appeal to the District in writing within ten (10) Calendar Days of the District's Decision. Failure to provide timely notice of an appeal constitutes a waiver of the Contractor's right to appeal.

The Claims Committee will conduct a Claim review meeting attended by representatives of the Contractor and the District. The Claims Committee will conduct the Claim Review Meeting within sixty (60) Calendar Days after the District receives the Contractor's notice of appeal. The proceedings of the Claim

Review Meeting 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 Claim Review Meeting will be made available to the Contractor. Within fifteen (15) Calendar Days of the Claim Review Meeting, the Committee's Chairperson will notify the Contractor, in writing, of the Committee's decision.

F. ***Decision of the Secretary.***

Either party may appeal the Claims Committee's decision to the Secretary requesting to proceed with the arbitration process as outlined in Section 105.15.G. The appellant shall give notice of the appeal to the Claims Committee's Chairperson, in writing, within ten (10) Calendar Days after receiving the Claims Committee's decision. Failure by either party to provide timely notice of an appeal constitutes a waiver of that party's right to appeal. After receiving the written notification, the Secretary or the Secretary's designee (usually the Chief Engineer) will notify the parties, in writing, within thirty (30) Calendar Days of the receipt of the notice regarding the Claim. The Secretary or the Secretary's designee will review the record and may schedule a meeting or hearing with the parties to discuss the Claim. The Secretary or the Secretary's designee will then issue a written decision that will serve as the final decision of the Department concerning the Claim.

G. ***Arbitration.***

Any Claim, properly presented and processed through the Claim procedure outlined above, and finally decided by the Secretary or the Secretary's designee pursuant to Section 105.15.F, 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 thirty (30) Calendar Days from the date of the written decision by the Secretary or the Secretary's designee, as provided in Section 105.15.F; 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. Failure by either party to provide a timely notice of appeal to the other constitutes a waiver of that party's right to appeal.

The arbitration proceeding may involve presentation of facts or such portions thereof as have previously been presented at prior administrative hearings held pursuant to Section 105.15 herein or may be based entirely upon the record, as established therein. The record established at prior administrative hearings pursuant to Section 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 Section 105.15 shall be admissible at any arbitration conducted pursuant to this Section, with the exception of the Contract Documents as defined in Section 101.03 Definitions - Contract. The arbitrators are to furnish a written decision to both parties that includes the findings of the panel and an explanation of the basis for the findings. This agreement to arbitrate will be strictly enforceable as provided under Chapter 57, Title 10 of the Delaware Code, as amended. The Contractor and DelDOT will each pay half of the arbitration fee and the cost of the court reporter.

H. ***Recoverable Costs.***

The Contractor is not entitled to recover any costs in a Claim other than those allowed by this Section. As described below, 1. through 5. identify all recoverable direct and indirect costs and 6. identifies all non-recoverable costs.

1. Labor. In accordance with Section 109.04 D.1.

2. Bond, Insurance, and Tax. In accordance with Section 109.04 D.2.

3. Materials. In accordance with Section 109.04 D.3.

4. Equipment. In accordance with Section 109.04 D.4.

5. Percentage Markups. In accordance with Section 109.04 D.6. and 109.04 D.7.

6. Non-recoverable Damages or Expenses. The expenses listed above as 1. through 5. shall constitute the sole cost(s) and expense(s) to which the Contractor is entitled on any Claim submitted for additional compensation or settlement of any Claim made under these Specifications, except as further provided in Section 105.15.J. The parties agree that the Department will have no liability for the following items of damage or expense:

    a. Profit in excess of that provided herein;

    b. Loss of profit;

    c. The costs of lost productivity for labor and Equipment either on this Contract or any other;

    d. Home office overhead in excess of that provided herein;

    e. Consequential damages, including but not limited to loss of Bonding capacity, loss of bidding opportunities and insolvency;

    f. Indirect costs or expenses of any nature;

    g. Attorney's fees, Claim preparation expenses or costs of litigation; and

    h. Interest on any claimed amounts.

Submit any Claim on behalf of a Subcontractor according to Section 105.15. Recoverable damages for Claims submitted on behalf of Subcontractors shall be solely limited to the list of all direct or indirect costs permitted by 1. through 4. above. For Work approved by the Department, the Subcontractor will be allowed a percentage markup as permitted by Section 109.04 D.6. and 109.04 D.7. The Contractor will be allowed an additional percentage markup as permitted by Section 109.04 D.8. to be computed on the final sum total of such Subcontractor cost Claimed under 1. through 4. above for portions of Subcontractor Work approved by the Department.

I. ***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 Section. 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 Section 108.07.

J. ***Claims for Delays.***

In order to receive an extension of Contract Time or to receive monetary compensation for delays to the Contract Schedule, the Contractor must request an extension of Contract Time in accordance with Section 108.07. Base all requests for extensions of Contract Time on the Contract's progress Schedule. Failure to properly update and maintain the progress Schedule in accordance with the terms of the Contract shall constitute a waiver of the Contractor's rights to claim for a time extension and/or monetary damages due to a delay.

The Department may grant time extensions in the performance of Work for delays caused by Acts of God as defined in Section 104.15. 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 is not entitled to recover any other damages resulting from such delays.

In the event that 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 to be the Department's sole responsibility, an extension of time will be granted in an amount equivalent to the actual critical delay caused by the Department, and the Contractor is not entitled to any additional compensation except as allowed herein. In the event that a delay that is the Department's sole responsibility is concurrent with a delay that was not the

sole responsibility of the Department, the Contractor is entitled to a time extension, but shall not be entitled to recover any other damages resulting from the concurrent delay.

All recoverable direct and indirect costs for compensable delays are identified in 1. below, and all non-recoverable costs for compensable delays are identified in 2. below. Compensation provided by 1. below shall not be duplicative of compensation already provided as part of Section 105.15.H or 109.04.

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

    a. Extended Field Overhead. Field overhead costs necessary for the prosecution of the Work during the delay period, as follows:

        i. General Field Supervision. Such costs include but are not limited to general field supervision, assistants, watchman, clerical and other field support staff that are physically located on the jobsite. Compute these labor costs in accordance with Section 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.

        ii. 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 that are physically located on the jobsite. 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.

        iii. Maintenance of Field Operations. Such costs include but are not limited to expenses for telephone, electric, water, and other similar services that are provided at the jobsite. 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 Section 109.04.D.7.

    b. 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 Section 109.04.D.1.

    c. Bond, Insurance, and Tax. In accordance with Section 109.04.D.2.

    d. 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 Section 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. No compensation is recoverable for idle Equipment unless 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.

    e. 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.

    f. Percentage Markups. An additional 10 percent markup of the total of a., b., c., and d. 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. This is the sole markup that is recoverable for a compensable delay. Markups from Sections 105.15.H.5., 109.04.D.6. and 109.04 D.7. shall not apply.

    g. Records. Payment will not be made for delays until the Contractor has furnished the Engineer with duplicate itemized statements of the cost as herein above specified and detailed as follows:

i. Name, classification, date, daily hours, total hours, rate, and extension for each worker and foreman.

ii. Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and Equipment.

iii. Transportation costs.

iv. 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, the records become the basis of payment for the expenses incurred, but do not preclude subsequent Adjustment based on later audits or inspections of the Contractor's records by the Department.

The Contractor's cost records pertaining to expenses under this Section shall be open to inspection or audit by representatives of the Department as provided in Section 105.15.K.

2. **Non-Allowable Damages or Expenses.** The expenses listed in 1. 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 Section 105.15.H.6.

K. ***Review of Contractor's Records by the Engineer.***

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. Ensure that such records are 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 Section 109.10. 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, 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 or inspection is to be commenced, the Engineer will provide the Contractor with a reasonable notice of the time when such an audit or inspection is to begin. In cases where all or a part of such records are not made available, the Contractor understands and agrees that any items not supported by records because the records are not made available will not be recoverable. If payment has already been made in such a case, refund to the Department the amount so recovered.

L. ***Contractor and Subcontractor/Supplier Disputes.***

Resolve 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 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.

105.16 Project Acceptance; Partial Acceptance. Final Acceptance will not occur until Completion of the Project as defined in Section 101.03. The Contract Time will be stopped at Substantial Completion as defined in Section 101.03.

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

Upon receiving notice from the Contractor of Substantial Completion, the District will conduct a semi-final inspection. During this inspection, the District will note by stations and in detail all Work or conditions requiring correction. Immediately prosecute the corrective Work. When the noted corrections are completed to the satisfaction of the District, the Department will conduct a Final Inspection to certify that the Project can be used, occupied, or operated for its intended use and that the Work has been satisfactorily completed in accordance with the Contract Documents. The Engineer will note any further corrective measures as deemed necessary. Prosecute corrective measures immediately. When the corrective Work is satisfactorily completed, together with receipt of proper documentation as noted herein, the Engineer will immediately accept the Project and notify the Contractor in writing of the date of acceptance of the Project. If the Contractor fails to complete the corrective Work identified by the Engineer within a reasonable period of time, usually two weeks, after the semi-final and Final Inspections, or the Contractor fails to submit proper documentation including final invoice, time charges will resume until such is completed. For each and every Calendar Day or Working Day, dependent on the type of Contract, charged beyond Substantial Completion that exceeds the allowable Contract time, the Contractor will be assessed Liquidated Damages in the amount of 10 percent of the value shown in Section 108.09.

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 a Final Inspection of that unit or portion of the Work. If the unit or portion of the Work has been completed in accordance with the Contract, the Engineer may accept it as completed. The decision to make a partial acceptance of a unit of Work is solely at the discretion of the Engineer. Partial acceptance will not void or alter any of the terms of the Contract.

SECTION 106 – MATERIAL QUALITY AND TESTING REQUIREMENTS

106.01 Source of Supply and Quality Requirements. Use Materials that meet the requirements of the Contract. Use only new Materials for incorporation into the Work unless otherwise specified in the Contract. 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 rejecting Materials at the supply source. If the Engineer determines that Materials met the requirements of the Contract at the supply source, but subsequently do not meet the Contract requirements at the jobsite either before or after incorporation in the Work, remove or correct the Materials to the satisfaction of the Engineer at the Contractor's cost.

106.02 Samples, Tests, and Referenced Specifications. All Materials must be approved by the Department prior to use in the Work. Use of unapproved Materials is at the Contractor's risk and unapproved Materials may be deemed unacceptable by the Engineer. The Engineer reserves the right to inspect and/or test all Materials at any time before or after incorporation into the Work. Removal and replacement of unacceptable Materials from the Work is solely at the Contractor's expense. Tests performed by the Engineer are for quality assurance purposes only. The Contractor is responsible for quality control of the Materials as defined in Division 1000 of these Specifications and is responsible for the condition of the Materials until the Project is accepted.

Unless otherwise designated, Material tests performed by the Department will be performed 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 and Research 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 and Research Manual

B. AASHTO

C. ASTM

The Engineer will set forth minimum requirements for sampling Materials on each Contract and will provide the Contractor with these requirements upon request. The Engineer must be afforded the opportunity to perform the minimum number of tests; and the Engineer reserves the right to perform more than the minimum number of tests. Material sampling or splitting operations will be performed or observed by the Department. Materials to be used are also 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 judgment of the Engineer, inconsequential quantities and use of Materials are required by the Contract, a field inspection report of Materials may be made by the Department 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 Section 105.11.

Distribute the certificates of compliance in accordance with the Contract or the Department's Materials and Research Manual.

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, meet the following conditions:

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. 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 Section 106.05;

D. Provide and maintain adequate safety measures; and

E. The Department reserves the right to retest any Materials upon delivery which have previously been tested at the source of supply and to reject all Materials which, when retested, do not meet the Contract requirements.

106.05 Field Laboratory. Provide a field laboratory conforming to Section 1022 for concrete and/or 1014 for bituminous asphalt. Payment for all field laboratories shall be incidental to the Work in the Section for which the laboratory or facility is provided.

106.06 Storage and Handling of Materials. Store and handle Materials to preserve their fitness for the Work. Store Materials in such a manner to facilitate prompt inspection. Stored Materials will be subject to inspection and retesting prior to incorporation in the Work in accordance with Section 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. Provide additional storage space that is required at the Contractor's expense and option. Do not use private property for storage purposes without written permission of the owner or lessee. If requested, furnish copies of such written permission to the Engineer.

Restore storage and plant sites to their original condition by and at the Contractor's expense.

106.07 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 by a method approved by the Engineer, in accordance with Section 106.08 at no additional cost to the Department.

106.08 Disposal of Unacceptable Materials. All waste Materials from the Work on the Contract become the property of the Contractor. Remove all waste Materials from the Project.

A. Procure disposal sites to dispose of all the waste Material generated by the Work on the Contract. Use disposal sites, if any, which are provided by the Contract Documents. Disposal sites that are provided by the Contract Documents may not be large enough to handle all waste Materials from the Contract. The Contractor is responsible to procure additional disposal sites if necessary to complete the Work.

B. Submit disposal sites for approval to the Engineer prior to utilization.

1. Provide a plan of the disposal area that includes the proposed sediment and erosion control devices, the existing contours and proposed final contours, a list of Materials to be disposed of in the disposal area, and the proposed security measures.

2. When preparing and utilizing off-site disposal areas, comply with all stormwater and environmental rules, regulations or applicable permits promulgated by the Department of Natural Resources and Environmental Control (DNREC), the U.S. Army Corps of Engineers (USACOE) or any other applicable government agency. Obtain permits, if necessary, in accordance with Section 107.02.

3. Costs for preparing these plans are incidental to the Contract Item that generates the waste.

C. For disposal sites designated in the Contract Documents, payment will be made separately under applicable Bid Items for all necessary erosion and sediment controls, seeding, and mulching.

D. For Contractor-procured disposal sites, costs for all necessary erosion and sediment controls, seeding, and mulching are incidental to the Contract Items that generate the waste.

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

Include the cost of handling and placing Department-furnished Materials after they are delivered to the Contractor 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. Investigate and strictly comply with all Federal, State, or County laws and regulations, and City or Town ordinances and regulations. 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 the Contractor as an entity or by the Contractor's 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, immediately report it to the Engineer in writing.

107.02 Permits, Licenses and Taxes. 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.

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. Furnish any patent agreement between patentee and the Contractor to the Department.

107.04 Contractor's Responsibility to Protect Utility Property and Services. At points where the Contractor's operations are adjacent to properties of railway, communications companies, power companies, or other utilities, or are adjacent to other properties, facilities, or appurtenances, and damage to which might result in considerable expense, loss, or inconvenience, do not commence Work 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, promptly notify the proper authority. Cooperate with the proper authority in the restoration of service as promptly as possible. Do not Work around or near fire hydrants until appropriate plans for continued service have been approved by the local fire authority.

Keep fire hydrants on or adjacent to the highway accessible to fire apparatus at all times and do not place any Material or obstruction within 15 feet of any such hydrant. Ensure that fire hydrants are entirely accessible at all points to fire apparatus at all times. Whenever any Work is performed in the area of a fire hydrant or whenever a fire hydrant is relocated or installed, the center of the hose outlet shall be a minimum of 18 inches above the final grade directly beneath the hose outlet. Set the breakaway flange at the bottom of a hydrant at 0 inches to 4 inches above the ground.

107.05 Federal Aid Participation. When the United States Government pays all or any portion of the cost of a Project, observe the federal laws authorizing such participation and the rules and regulations made pursuant to such laws; 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. Do 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. Expressly state this requirement in each subcontract agreement.

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, interfere as little as possible with traffic. Provide and maintain ingress and egress for all residences and places of business located along the construction route. Place Materials stored upon the highway in accordance with the MUTCD and, so far as practicable, in a manner that causes as little obstruction to the traveling public as possible. If, as determined by the Engineer, the road or any portion of it must remain open to travel during construction of the Project, perform the Work so that travel through the jobsite is safe and unobstructed. Provide and maintain in an acceptable condition any temporary roadways and Bridges that are necessary to accommodate the traffic using or diverted from the roadway under construction, and provide and maintain in a safe condition temporary approaches to and crossing of intersecting highways. Do not obstruct sidewalks, gutters, sewers, inlets, and portions of the highway adjoining the roadways under construction more than is absolutely necessary to complete the Work.

Maintain a safe work site at all times and be prepared to make repairs as needed after normal working hours in the case of an emergency. If the Department is unable to contact the Contractor to make these repairs then State maintenance forces or a third party contractor may be used to make such repairs. The cost for this Work will be calculated according to Section 109.04.D for all State personnel involved or third party contractors, including vehicles, Equipment and Materials needed. This cost will be deducted from money due the Contractor under this Contract. The failure of the Contractor to be available and to make emergency repairs is sufficient grounds for the Department to terminate the Contract for default.

107.08 Use of Explosives. When the use of explosives is necessary for the prosecution of the Work, exercise the utmost care not to endanger life or property, including new Work. Assume responsibility for all damage resulting from the use of explosives.

Store all explosives in a secure manner in compliance with all laws and ordinances, and clearly mark all such storage places. Where no local laws or ordinances apply, provide storage satisfactory to the Engineer and not closer than 1000 feet from the road or from any building or camping area or place of human occupancy. Follow the requirements of the MUTCD in storing explosives and flammable liquids.

Notify each public utility company having Structures in proximity to the site of the Work of the intention to use explosives. Give such notice sufficiently in advance of the Work 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 feet of any existing, newly finished, or partly finished Structure on a Project unless authorized in writing by the Engineer. Do not store explosives overnight on the Project.

107.09 Protection and Restoration of Property. Assume responsibility 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. Take the precautions necessary to prevent damage to pipes, conduits, and other underground Structures, and protect from disturbance or damage all land monuments and property markers until Project Acceptance. Locate and reset any land monument or property markers damaged or disturbed during the Project using a Land Surveyor or a Professional Engineer registered in the State of Delaware. Do not injure or destroy trees or shrubs outside the Limits of Construction, 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, restore such property 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. Assume the responsibility and liability for, and 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 applies to, 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 will 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 securing 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 Contractor's Responsibility for the Work after Final Acceptance; 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, will not preclude or estop the Department from correcting any measurement, estimate, or certificate made before or after Completion of the Work, nor will 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, is liable to the Department after Final Acceptance 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 Materials Discovered Within the Project Limits. If any condition is encountered or exposed that indicates the presence of a hazardous material or toxic waste, immediately suspend construction operations in the area and notify the Engineer. Continue Work in other areas of the Project unless otherwise directed by the Engineer.

Conditions indicating the presence of a hazardous material or toxic waste include, but are not limited to, the following: presence of barrels, chemical odors, excessively hot earth, smoke, or any other condition that indicates a hazardous material or toxic waste. Treat such conditions with extreme caution.

The Engineer will arrange for disposition of the hazardous material or toxic waste by a third party Contractor at the Department's expense.

SECTION 108 – SUBCONTRACTING; NTP; PROGRESS SCHEDULES; TIME EXTENSIONS; LIQUIDATED DAMAGES; TERMINATION

108.01 Subletting of the Contract. Perform Work with the Contractor's own organization amounting to not less than **50 percent** of total original Contract Price, excluding any specialty Items designated by the Contract. Specialty Items may be performed by subcontract and the amount of any such specialty Items performed may be deducted from the total original Contract Price before computing the amount of Work required to be performed by the Contractor's own organization. The Contract upon which the requirements are computed includes the cost of Material and manufactured products that are to be purchased or produced by the Contractor under the Contract provisions. Adjustments in quantities or additional Items of Work shall not require an Adjustment of the percentage computed as described above.

The term "perform Work with its own organization" refers to workers employed or leased by the prime Contractor, and Equipment owned or rented by the prime Contractor, with or without operators. Such term does not include employees or Equipment of a Subcontractor or lower tier Subcontractor, agents of the prime Contractor or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime Contractor meets all of the following conditions:

A. The prime Contractor maintains control over the supervision of the day-to-day activities of the leased employees;

B. The prime Contractor remains responsible for the quality of the Work of the leased employees;

C. The prime Contractor retains all power to accept or exclude individual employees from Work on the Project; and

D. The prime Contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other federal regulatory requirements.

"Specialty Items" are limited to Work that requires highly specialized knowledge, abilities, or Equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the Contract as a whole and in general are intended to be limited to minor components of the overall Contract. All Specialty Items will be expressly identified in the Contract.

Do not sublet, sell, transfer, assign or otherwise dispose of any portion of the Contract except with the written consent of the Engineer. Such consent, when given, does not relieve the Contractor of any responsibility for the fulfillment of the Contract. Do not 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. Written consent will only be given after the Engineer has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime Contract.

If the Contractor proposes to subcontract any part of Work, outline the scope and value of the Work to be performed by the Subcontractor. Outline the cost of Materials to be used by the Subcontractor. Include the cost of Materials to be used by the Subcontractor in the value of the subcontracted Work. A Subcontractor shall not subcontract further a portion of the Work without the express written permission of the Engineer. In granting such permission, the Engineer will ensure that the Subcontractor seeking to subcontract the Work to be performed by another shall nonetheless perform with its own organization Work amounting to not less than 50 percent of the total subcontracted bid price.

Perform all the traffic control Work and related Items either (1) entirely with labor, Equipment and Materials from the Contractor's own organization; or (2) entirely with labor, Equipment and Materials from a single Subcontractor. Maintenance of the Equipment will 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 will be applied to fulfill Disadvantaged Business Enterprise (DBE) requirements of the Contract, where applicable. The cost of the portion of the Contract or Bid Item performed by a DBE will be included in the total amount of Work subcontracted by the Contractor in determining whether the Contractor is performing at least 50 percent of the total Contract Bid Price, as required by this Section.

As a prerequisite to payment for any Work performed by a Subcontractor or on a Subcontractor's behalf and prior to any Work being performed on the Project by any Subcontractor, submit a certified copy of the Contractor-Subcontractor agreement and a copy of the Subcontractor’s Delaware business license. Also include 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. The Contractor is solely responsible to determine that all such provisions are included and such provisions will 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. Evidence that 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. Assurance that all Civil Rights provisions and DBE requirements have been satisfied.

Include provisions in all subcontracts that indemnify and save harmless the Department from the action of the Subcontractor or supplier; provisions that provide for the binding arbitration of all disputes between the parties to the subcontract agreement; and provisions that save harmless and indemnify the Department for omissions in the subcontract agreement.

Any review performed or permission or approval granted under these Specifications will not operate, nor be interpreted as approval of the Work to be performed by the Subcontractor or Material supplied by a supplier, nor 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 will in any case release the Contractor of its sole responsibility and liability under the Contract and Bonds.

The Department, at its discretion, may refuse to pay for or accept all or part of the Work or Materials supplied by an unapproved Subcontractor or Materials supplier and may refuse to consider such Work performed or Materials supplied as part of the subcontracted Work.

108.02 Preconstruction Meeting; Submitting a Schedule; Notice to Proceed. Following the execution of the Contract, the Engineer may schedule a preconstruction meeting. Prior to the preconstruction meeting, submit the progress Schedule per Section 108.04. After the preconstruction meeting, the Engineer will issue to the Contractor a Notice to Proceed which will stipulate the date on or before which the Contractor must begin Work. The date specified in the notice will be at least ten (10) 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 will begin on the Day the Work actually starts or on the date stipulated in the Notice to Proceed, whichever is earlier.

108.03 Commencement of Work; Counting Contract Time. Begin Work no later than the date stipulated in the Notice to Proceed. Contract Time will be counted using either Calendar Days or Working Days, whichever is indicated in the Bid Proposal.

A. Calendar Day Contracts. Contract Time will begin as specified in Section 108.02 and continue each and every Day shown on the calendar until the Substantial Completion of the 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. If the Contractor wants to perform Work on Sundays and/or Holidays, submit a written request to the Engineer at least three Working Days prior to the Sunday or holiday for approval to perform Work on such Sunday or Holiday. Provide notice to the Engineer no later than 12 PM Friday if any Work is to be performed that week on Saturday so that adequate inspection can be provided by the Department.

B. Working Day Contracts. Contract Time will begin as specified in Section 108.02 and continue as defined in Section 101.03 until Substantial Completion of the 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 approval 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 that week on Saturday so that adequate inspection can be provided by the Department.

108.04 Contractor's Resources; Progress Schedules. Provide sufficient Materials, Equipment, and labor to complete the Project within the Contract Time. Lack of resources is not a sufficient reason for an extension of Contract Time.

Submit a Progress Schedule to the Engineer for review. Do not start Work until the Progress Schedule is approved 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 will be used to establish the critical construction operations and to monitor the progress of the Work. Submit the progress Schedule chart in the form specified below, unless the Contract requires a Critical Path Method (CPM) Schedule. When the Contract requires a CPM Schedule, the specifications for preparing and maintaining the Schedule will be set forth in the Special Provisions. The cost of preparing and maintaining a progress Schedule is incidental to the Contract unless otherwise specified in the Contract Documents.

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

A. **Progress Schedule Chart.** Prepare a Progress Schedule Chart ("PSC") that shows in detail the time (Working Days or Calendar Days as specified) involved in performing construction activities for the duration of the Project. Schedule the Project in such manner and sequence as to minimize the time and surface area of erodible earth material. Use the PSC 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. Show the impact of utility activities, permits and interdependent Work between separate Project locations, if applicable.

   Fully use, but do not exceed, the specified Contract duration in the PSC. 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 nor constitute acceptance of any individual time period for scheduled activities.

B. **Biweekly and As-Required Look-Ahead Schedules.** Submit to the Engineer a two-week activity Schedule on each Friday for each two-week period of Work activity. 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 requesting an extension of Contract Time as specified in Section 108.07 and if required by the Engineer, submit a revised detailed progress Schedule showing the remaining Work to be completed and

any delay periods that affected the Schedule. The Engineer also reserves the right to require the Contractor to submit a revised Schedule when the Contractor performs a significant amount of the Work out of sequence from the approved Schedule.

Monthly Payment Chart. Unless otherwise noted on the Plans submit to the Engineer, as part of the PSC or CPM Schedule submittal, an estimate of the monthly payments expected to be received on the Contract. This estimate will be referenced as the "Monthly Payment Chart". The Monthly Payment Chart can be generated by hand, or by a word processor or spreadsheet. Include, as a minimum, columns showing estimated monthly payments for the duration of the Contract Time. The total of all estimated monthly payments must equal the Awarded Contract total Bid Price. The Engineer may request an updated "Monthly Payment Chart" depending on the accuracy of the initial estimates and according to the overall needs of the Department. The Monthly Payment Chart is not binding on either the Department or the Contractor. The purpose of the chart is to help the Department plan its budget so that Contractors can be paid each month as quickly as is practicable.

Costs to prepare and/or update the "Monthly Payment Chart" are addressed as follows:

A. On Contracts requiring CPM Schedules and Updates, these will be addressed with Special Provisions.

B. On Contracts not requiring CPM Schedules, the cost to prepare and update the "Monthly Payment Chart" is included in Item 763000, Initial Expense.

108.05 Traffic Requirements and Contractor's Operations; Completing Work. Schedule and conduct Work in such a manner and in such sequence as will ensure the least interference with traffic. Do 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 Preference for Delaware Labor; Character of Workers and Equipment; Specified Construction Methods. 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, give preference in employment of laborers, workers, or mechanics to bona fide 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 will 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 requirement to give preference to Delaware laborers, workers or mechanics shall not apply to federally funded Contracts.

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 himself/herself improperly, discharge the employee, upon the request of the Engineer, from the Work and do not again employ that person on the Contract or any other Contract for the Department, except with the written consent of the Engineer.

Use only machinery and Equipment that is of sufficient size and capacity to obtain satisfactory quality in the performance of the Work. Do not use Equipment that injures the Work, adjacent property or public roads. When the Contract specifies that the Work be performed by the use of certain methods and/or Equipment, use such methods and/or Equipment unless alternatives are authorized by the Engineer. Submit requests for the use of alternative Equipment or methods in writing for approval. If approval is given, the Contractor will be fully responsible for producing 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, discontinue the use of the substitute method and/or Equipment and complete the remaining construction with the specified methods and/or Equipment.

If substituted methods or Equipment produce deficient Work, remove the deficient Work and replace it with Work of specified quality, or take such other corrective action as the Engineer may direct. No additional compensation or increases in Contract Time will be allowed as the result of authorizing a change in methods and/or Equipment under these provisions unless it is as a credit to the Department or a VEP.

108.07 Extensions of Contract Time; Weather Delays. If the Contractor cannot complete the Work within the time allowed by the Contract due to a delay or delays that meet the criteria of Section 105.15.J, submit a written

request to the Engineer for an extension of time for Completion of the Contract. Submit the reasons justifying the delay. All time analysis will be performed based on the approved Contract Schedule. Failure to submit an acceptable Schedule or failure to properly maintain the Schedule forfeits the Contractor's right to a time extension. If requested by the Engineer, submit a revised detailed progress Schedule showing the remaining Work to be completed on the Project. If the Engineer finds that the request for an extension of time is justified, the Engineer will grant an extension of time in such amount as the Contractor proves to be reasonable and proper. Upon written notice being sent by the Engineer, the new Completion time will 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 to the Schedule without articulating a valid reason that is permitted by these Specifications.

The Contractor is presumed to have included in its Contract price allowance for any reasonably anticipated delays in procurement of Materials and procurement is the Contractor's sole responsibility. Unless some unusual market condition such as an industry-wide strike, natural disaster, or area-wide shortage arises after bids are taken and prevents procurement of Materials within the allowable time limitations, delays in delivery of such Materials are not sufficient reasons for extending the Contract Time.

For Contracts that do not provide an allowance for Weather Days in the Contract Documents, follow the requirements of Section 105.15.J to determine if weather warrants and extension of Contract Time.

For Contracts that provide an allowance for Weather Days, the term "Weather Day" means any Calendar Day, including weekends, Holidays and non-Work periods, on which weather conditions would prevent a Contractor from performing Work, whether or not the Contractor was scheduled to Work that Day. For each Weather Day that occurs on a jobsite, submit a request to the Engineer for that Day to be counted as a Weather Day. When the total number of Weather Days that are submitted and approved exceeds the number of allowable Weather Days provided in the Contract, Contract Time will be extended one Calendar Day for each Calendar Day that Work cannot progress due to the impact of weather. Such extensions will only begin accruing once the allowable Weather Days are exceeded and Contract Time will only be adjusted for Weather Days that occur after the number of allowable Weather Days has been exceeded. For Contracts without CPM Schedules, Calendar Days lost to weather do not need to occur on a critical path in order to be considered for an extension of Contract Time.

108.08 Failure to Complete on Time. For each Calendar Day or Working Day that Work remains uncompleted after the Contract Time has expired, the sum specified in Section 108.09 will be deducted from any money due the Contractor. This sum is not a penalty, but is a Liquidated Damage assessed to recover the cost 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 Section 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 will 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, will be included in the computations for the assessment of Liquidated Damages.

Assume liability for Liquidated Damages for delays commencing from the date on which the Contract Time, as adjusted by Section 108.07, expires. The Department will not pay the Contractor for maintenance of traffic (MOT) devices or measures used during periods when Liquidated Damages are assessed. This includes, but is not limited to, MOT devices, flaggers, traffic officers and any lump sum MOT Items that may be included in the Contract. Additionally, the Department will not pay the Contractor for field office items or CPM updates used during periods when Liquidated Damages are assessed.

Permission for the Contractor or Surety to continue and finish Work after the Contract Time and approved extensions have elapsed will 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 that the total Liquidated Damages due exceeds the 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	$410.00	$ 290.00
25,000	50,000	420.00	300.00
50,000	100,000	570.00	400.00
100,000	500,000	880.00	630.00
500,000	1,000,000	1,140.00	820.00
1,000,000	2,000,000	1,410.00	1,000.00
2,000,000	5,000,000	1,480.00	1,060.00
5,000,000	10,000,000	1,650.00	1,180.00
10,000,000	15,000,000	2,620.00	1,870.00
15,000,000	20,000,000	4,380.00	3,130.00
20,000,000	25,000,000	6,110.00	4,360.00
25,000,000	30,000,000	7,850.00	5,610.00
30,000,000	35,000,000	9,610.00	6,860.00
35,000,000	over	11,340.00	8,100.00

108.10 Default of the 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 judgment to stand unsatisfied for a period of ten (10) Days.

F. If the Contractor makes an assignment for the benefit of creditors without authorization by the Department.

G. If the Contractor, 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 (10) Days after receiving a written notice of default from the Engineer, fails to remedy the situation to the satisfaction of the Engineer, 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 Section 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 Section 108.11.

108.11 Termination of the Contract for Convenience. 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 as provided in Section 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, submit, within sixty (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, 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 direct cost or direct damage 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 the Contractor's Responsibility. The termination of the Contractor's responsibility for the Work occurs upon Final Acceptance in accordance to Section 105.16, except to the extent provided in Section 107.13.

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).

Unless stated otherwise, all Material that is to be measured by weight and will be measured as follows:

A. Weigh each loaded truck or other approved hauling Equipment and then deduct the tare weight of the truck or hauling Equipment. Check the tare weight once daily, or as often as directed by the Engineer. Make appropriate adjustments in the use of the tare weight as directed by the Engineer. Computer generate all weight tickets. Antiquated

B. Use a scale platform 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. The State sealer of weights and measures will certify all scales used to weigh loads for payment.

A station, when used as a definition or term of measurement, will be 100 linear feet. 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 or less. Transverse measurements for area computations will be the neat dimensions shown on the Plans.

Measure Structures according to neat lines shown on the Plans or other Contract Documents.

For Items measured by linear foot, such as pipes, 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. 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 used for payment. However, car weights will not be acceptable for Material to be passed through mixing plants. Weigh empty trucks used to haul Material being paid by weight 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 may be weighed and such weights will be converted to volumes for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer. The Engineer and the Contractor must mutually agree to use such conversions before using them. If no agreement can be reached, the Material will be measured in place by volume.

Bituminous Materials will be measured by the gallon.

Volumes will be measured at 60 degrees Fahrenheit or will be corrected to the volume at 60 degrees Fahrenheit using ASTM D4311 for asphalt or ASTM D633 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.

Timber will be measured by the actual thousand feet board measure, MFBM, 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 specified elsewhere in the Contract, manufacturing tolerances established by the industries involved will be accepted.

109.02 Scope of Payment for Unit Prices; Payment of Subcontractors. Receive and accept compensation provided 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, and expense of every kind arising out of the nature of the Work or the performance thereof, subject to the provisions of Section 107.13.

If the "Basis of Payment" clause for an Item relating to a Unit Price in the Contract requires that the Unit Price cover and be considered compensation for certain Work or Materials used to complete the Work for that Item, this same Work or Material will not be measured or paid under any other Pay Item appearing in the Contract.

When requirements, responsibilities and/or furnishing of Materials (collectively called “Requirements” in this Section) are outlined in the details, notes on the Plans and/or in the paragraphs preceding the “Basis of Payment” paragraph in these Specifications or Special Provisions, such Requirements are included in the payment for the Item. No separate payment will be made for the above mentioned Requirements even if those requirements are not expressly reiterated in the “Basis of Payment” Section of the specification.

Within 30 Days of receipt of any payment from the Department, file a statement to the Department on a form furnished 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, accept payment at the original Contract Unit Prices for the accepted quantities of Work performed. No allowance will be made for any increased cost, except as provided in Sections 104.06, 104.07, 104.08, and 108.11 and/or in any escalation clauses provided in the Contract Documents.

109.04 Payment for Differing Site Conditions, Major Changes, Extra Work, and Force Account. When the Contract requires the Department to compensate the Contractor for Differing Site Conditions, changes to the Contract, and/or Extra Work, (collectively called "Changed Work" in this Section) the Department and the Contractor shall jointly choose one of the following methods to calculate the compensation owed to the Contractor:

A. Perform the Changed Work at Contract Unit Prices;

B. Renegotiate the Unit Prices for the Changed Work;

C. Negotiate a lump sum payment for the Changed Work;

Should negotiated new prices or renegotiated existing price(s) involve Work to be performed by a Subcontractor, the Contractor's total allowable mark-up on the subcontracted portion of the Work shall not exceed 10 percent of the Subcontractor's proposed price. Upon request by the Department, submit documentation substantiating the price of the Subcontractor's proposed Work.

Should the Engineer and the Contractor fail to agree on a method of compensation for Changed Work, the Engineer may direct the Contractor to perform the Changed Work, provided that the Changed Work is within the scope of the Contract. When the Contractor performs Changed Work at the direction of the Engineer, the Work is called "Force Account Work" and the Contractor will be compensated following the procedure set forth below.

D. Perform the Changed Work on a time and material basis using the rules for "Force Accounts" described below to determine payment.

   Prior to starting Force Account Work, the Engineer and the Contractor must meet to determine the labor, Equipment and Materials that are necessary to perform the Work. The Engineer will make the final determination concerning what labor, Equipment and Materials are necessary. The Contractor must follow the direction of the Engineer when performing the Force Account Work. Force Account Work is to be compensated in the following manner except as further provided in Section 105.15:

   1. ***Labor***. Receive as compensation the rate of wage (or scale) actually paid as shown on its certified payrolls for each and every hour that necessary labor and foremen are actually engaged in the Force Account Work. Superintendents, general foreman, or other general supervisors of the Force Account Work are compensated by the overhead markup in Section (7.) below and are not paid as labor.

      Receive as compensation 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, receive the actual incremental cost thereof, necessarily and directly resulting from the Force Account Work. 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. Make no Claims for costs and markup on such Materials.

      Only Materials furnished by the Contractor and necessarily used in the performance of the Force Account Work will be paid under this Section. The cost of Contractor furnished 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, credit that amount 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***.

Use only Equipment that is, in the opinion of the Engineer, in good operating condition. Specifically describe the Equipment used when documenting such Equipment for payment. Use Equipment 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 or payment value than that suitable for the Work, payment will be made at the rate applicable to the suitable Equipment. The 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.

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. These 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. The Blue Book will be used in the following manner:

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

ii. 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, not to exceed 176 hours per calendar month.

iii. The current revisions to the Blue Book 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.

iv. An area adjustment will be made. Equipment life adjustment will be made in accordance with the rate adjustment tables in the Blue Book. Charge overtime at the same rate indicated in i. above.

v. 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.

vi. Idle time for Equipment or plant will not be paid, except where the Equipment has been held on the Project site on a standby basis at the written 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 i. and iv. above. Such payment will not exceed 8 hours in a Day and will not exceed 40 hours in a week.

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

viii. Operator costs are not included in this hourly rate for this Equipment or plant.

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.

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, inform the 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 if such moves are solely necessitated by the Force Account Work. For idle rental Equipment that must remain on the site because of a written directive from the Engineer and would have left the site but for that directive, the rented Equipment will be paid at the rental rate established above, not to exceed 8 hours per Day and not to exceed 40 hours per week. In no case will the Department pay the Contractor for equipment costs in excess of the actual cost paid by the Contractor for the rental. 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 tools whose Blue Book value is less than $1,500.00; or other costs for which no specific allowance is herein provided.

6. ***Profit***. Profit shall be computed at 5 percent 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 Section 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 tools whose Blue Book value is less than $1,500.00, including, but not limited to, 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 will be computed at 10 percent 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 Section 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 a 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, receive an amount equal to 10 percent for Work up to $100,000.00 and 5 percent for Work exceeding $100,000 of the total of such Work completed as set forth in 1. through 4. above.

9. ***Records***. 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, furnish the Engineer completed daily Force Account Work reports for each Day's Work to be paid for on a Force Account basis. Sign and submit such reports daily. Detail the daily Force Account Work reports 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. Costs for transportation of Materials.

   e. Cost of property damage, liability, and workers compensation insurance premiums; unemployment insurance contributions; Bonds; and social security tax.

Substantiate Material charges with valid copies of vendor's invoices. Submit such invoices with the daily Force Account Work reports, or, if not available that Day, submit them with subsequent daily Force Account Work reports. Should the vendor's invoices not be submitted within sixty (60) Days after the date of delivery of the Material, or within fifteen (15) Days after the Completion of the Work, whichever occurs first, the Engineer 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 Section 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, the reports become the basis of payment for the Work performed, but do not preclude subsequent Adjustment based on a later audit by the Department.

Allow cost records pertaining to Work paid on a Force Account basis to be open to inspection or audit by representatives of the Department as provided in Section 105.15.K.

109.05 Basis of Payment for Fixed Quantity Items. When indicated on the Plans, Bid Proposal and/or the Specifications, certain Items will be paid on an estimated fixed quantity Item basis. Where this occurs, the method of measurement and basis of payment indicated in these Specifications is modified for such Items as identified in this Section.

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 Bid Prices, except in certain situations described below in (A), (B) and (C) of this Section.

When bidding, check the estimates provided in the Contract Documents and appraise the actual 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:

A. The Contractor encounters a Differing Site Condition that causes the estimated fixed quantity to change;

B. The Engineer adds or deletes Work to the Contract that increases or decreases a fixed quantity Item; or

C. The Contractor contests the fixed quantity and can show that the actual quantity of the Work performed is more than 25 percent of the estimated fixed quantity.

When Differing Site Conditions cause an estimated fixed quantity to change, the Engineer will adjust the payment in accordance with Section 104.07 of these Specifications. When the Engineer adds or deletes Work, the actual quantity of Work that is added or deleted will be added to or deleted from the estimated fixed quantity. If estimated fixed quantity Items are deleted completely, no payment will be made.

In cases where a fixed quantity is contested by the Contractor, provide necessary measurements and computations to support a change in the quantity. If the change is verified and approved by the Engineer and the error in the estimated fixed quantity exceeds 25 percent, the Contractor will be compensated at the Unit Bid Price for the actual quantity of Work performed under 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 will not invalidate the Contract. When the Contractor is notified of the elimination of Items, the Contractor will be reimbursed for the actual Work performed and all direct expenses incurred in preparation for the eliminated Item as calculated by the Force Account procedure outlined in these Specifications. Reimbursement of Materials actually purchased prior to notification of the elimination of Items will be paid at the actual cost of the Materials plus 15 percent (overhead and profit). Such Materials will become the property of the Department. In no event will reimbursement for an eliminated Item exceed the Bid Price of the Contract Item. Also, in no case will the Contractor be reimbursed for the loss of anticipated profit.

109.07 Estimates; Retainage. The Engineer will once in each month make an estimate, in writing, of the total amount of Work performed on the Contract and the value of the completed Work to the date of the estimate. Five percent of the value of the Work performed as indicated by the estimate may be retained as security for fulfillment of the Contract until a total of 5 percent of the total bid price has been retained. Securities may be substituted for this retainage in accordance with Section 6962, Chapter 69, Title 29 of the Delaware Code and as amended. Payment of estimates, except final estimates, will not exceed those shown on the Proposal except those authorized by Change Order. No such estimates or payments will 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 performed 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 Stored Material. When approved by the Engineer, 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 an invoice or purchase order on the supplier’s letterhead documenting the cost of 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 percent of the cost to the Contractor for Materials, not to exceed 90 percent of the Contract Item price, may be made when such Material is delivered and stockpiled or stored in accordance with the requirements specified in the Contract Documents.

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

   Payment will not be allowed in excess of the Unit Bid Price of the quantity required for the Contract. Base the required quantity on the Contract bid quantities and approved revisions.

C. Excluded Materials. No allowance will 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 will 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 or an environmental, or safety restriction.

D. Storage. Store all Materials in an approved manner and in areas where damage is not likely to occur. Dedicate the stored Material to the Project.

   When Materials cannot be practically stored 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 the Engineer’s 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 will be included in the progress estimate as a new and separate Item and will be subject to retainage provisions. Submit proof of payment to the Engineer prior to processing the next progress estimate in the form of a paid invoice from the Material supplier. Failure to submit proof of payment prior to the processing of the progress payment will result in the deduction of the applicable Material payment in its entirety from progress payments until such time as the proof of payment is received by the Engineer. As the Materials are incorporated into the Project and the Work is paid under the applicable Unit Price(s), an equal percentage of the Material allowance will be deducted from progress estimates until 100 percent 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 Withholding of Money Due on an Estimate to Offset a Contractor's Liability. Whenever Liquidated Damages are assessable, such damages will 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 will 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, 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 percent 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; Time Limit to Challenge Quantities. The Engineer will, as soon as practicable after the Completion of the Contract, make a final estimate of the Work performed and the value of such Work, and the Department will 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 will be subject to correction in the final estimate payment. Give notice to the Engineer of any alleged errors in the payment of Contract quantities. Such notice must be given to the Engineer within 120 Calendar Days of the date when the Engineer gives the Contractor notice that the Contract's quantities have been finalized. Failure to notify the Engineer within this time frame constitutes a waiver of the Contractor's right to contest the quantities. Nothing in this Section serves to preclude the Engineer from performing audits of its own records or the Contractor's records and to adjust payment based on such audits in accordance with other provisions in the Specifications.

The acceptance by the Contractor of the final estimate operates as and is a release to the State, the Department, the Secretary, 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 Secretary, 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 a Claim for extra compensation.

109.12 Transportation Tax Exemption. Base all Unit Prices 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, 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.

DIVISION 200 – EARTHWORK

SECTION 201 - CLEARING AND GRUBBING

201.01 Description.

Clear, grub, remove, and dispose of all rubbish, vegetation, and organic debris within the Limits of Construction except such objects that are designated to remain or that are to be removed in accordance with other Sections.

201.02 Materials. Not applicable.

201.03 Construction.

201.03.1 General. Clear and grub all vegetation, trees, stumps, roots, and other debris.

A. Replace any suitable embankment and topsoil Material removed by mechanical Equipment during clearing and grubbing.

B. Use a root rake if large quantities of suitable embankment and topsoil Material are being wasted during the grubbing operation.

201.03.2 Trees and Roadside Amenities Designated to Remain.

A. Protect trees, shrubbery, plants and roadside amenities, such as signs, light posts or other improvements designated not to be removed.

B. Protect trees designated to remain by placing construction safety fence at the drip line of the trees within the Limits of Construction.

C. Replace or repair, as directed by the Engineer, any damaged shrubbery, plants or roadside amenities.

D. Have a certified tree surgeon evaluate all trees that have been damaged by the clearing and grubbing operations and which are designated to remain; follow the recommendations of the certified tree surgeon for repair or replacement of the trees.

E. Prune trees branches overhanging the roadbed to maintain a vertical clearance height of 20 feet above the roadway elevation.

F. Prune trees or shrubs overhanging the sidewalk to achieve a vertical clearance height of 10 feet above the sidewalk elevation.

G. Perform all required pruning in accordance with ANSI A300.

201.03.3 Disposal. Dispose of all waste materials removed by the clearing and grubbing operation as specified in Section 106.08.

201.03.4 Preparation of Ground Surface.

A. Perform clearing, grubbing and excavation for installation of necessary ditches and sediment controls before clearing and grubbing the remainder of the Contract.

B. Do not start excavation or grading operations in any area until all clearing and grubbing Work in that area is complete.

C. Depth of clearing and grubbing:

1. In excavation areas:

   a. Clear the ground of all living or dead trees, stumps, brush, or other debris.

   b. Remove all embedded stumps, root mats, etc., to a depth of at least 2 feet below subgrade or the slope surface.

2. In areas receiving Embankment of less than 5 feet in depth when measured from the bottom of the fill to either the subgrade or the sloped surface:

a. Clear the ground of all living or dead trees, stumps, brush, or other debris.

b. Remove root mat to the following minimum depths unless otherwise specified in the Contract:

i. Forested areas within tree lines shown in the Contract Documents: 2 feet

ii. Scrub wooded areas: 1 foot

iii. Field areas: vegetation only

3. In areas receiving Embankment of 5 feet or more in depth when measured from the bottom of the fill to either the subgrade or the sloped surface:

a. Cut off trees and stumps as close to the ground as is practicable but no more than 6 inches above the ground surface and clear the ground of all living or dead trees, stumps, brush, or other debris.

D. If cross sectioning is required, level and compact the existing Material after clearing and grubbing operations are successfully completed and before cross sectioning and placement of Embankment lifts.

E. Based on soil conditions encountered after completion and acceptance of clearing and grubbing, the Engineer reserves the right to restrict all earth-moving activities for a maximum duration of fourteen (14) Calendar Days to allow for drying and solidification of the ground.

201.03.5 Clearing and Grubbing Limitations.

A. The Engineer reserves the right to limit clearing and grubbing operations to ensure compliance with the applicable erosion and sediment control regulations and specifications.

The maximum exposed surface area of erodible soil from clearing and grubbing is 20 acres.

201.04 Method of Measurement.

Clearing and grubbing will not be measured.

201.05 Basis of Payment.

Clearing and grubbing will be paid at the lump sum Unit Price. Such payment is full compensation for leveling and compacting existing Material; for protecting trees, shrubbery, plants and other roadside amenities that are to remain; for replacement or repair of damaged trees, shrubbery, plants or other roadside amenities that are to remain; for the services of a tree surgeon or arborist in evaluating damaged trees; for disposal; and for all labor, Equipment, tools, and incidentals required to complete the Work.

Construction safety fence used to protect trees and roadside amenities designated to remain will be measured and paid under Item 727006 – Construction Safety Fence.

All costs associated with the Engineer's direction to restrict earth-moving activities will be considered incidental to the Work.

ITEM	DESCRIPTION	UNIT
201000	CLEARING AND GRUBBING	L.S.

SECTION 202 – EXCAVATION AND EMBANKMENT

202.01 Description.

Excavate, haul, dispose of, place, and compact specified Materials necessary to construct the Project in accordance with the Contract Documents and as directed by the Engineer.

202.02 Material.

Provide Materials as specified in:

Borrow	Section 209; Section 1001
Concrete	Section 1022
Flowable Fill	Section 208; Section 1047

202.03 Construction.

202.03.1 General.

A. Clear, grub, and remove topsoil before beginning excavation, grading, and Embankment operations.

B. Perform adequate survey layout per Section 105.10 prior to performing excavation and Embankment operations.

C. Salvage topsoil as specified in Section 908.

D. Provide a uniform and smooth finish to excavation and Embankment surfaces.

E. Obtain the Engineer's approval before removing from the site excavation material that is suitable for use in Embankments.

F. Maintain drainage during excavation and Embankment operations by:

1. Cleaning and clearing obstructions from all existing ditches and waterways.

2. Cleaning and clearing all new or existing pipes and Culverts, unless noted in the Contract Documents to be abandoned.

3. Clearing any other debris restricting positive drainage within the Limits of Construction.

G. Excess and unsuitable material is the property of the Contractor unless otherwise specified in the Contract Documents. Remove all excess and unsuitable materials from the Project and dispose of as specified in Section 106.08. Do not place excess or unsuitable material in wetlands.

H. Cover existing rocks and boulders with at least 12 inches of Embankment Material.

202.03.2 Obstructions. Remove and properly dispose of pipes except those, designated as a Bridge, underdrains, drainage inlets, conduits and all obstructions not covered under Section 211 that are located below existing ground level within the excavation limits.

A. Fully remove sections of pipes that are partially within the excavation limits under this Section.

B. Remove all pipes entirely. Submit any requests to abandon pipes in place to the Engineer for approval. Upon approval, fill pipes abandoned in place with flowable fill and plug both ends with Class C concrete as shown in the Contract Documents.

C. Salvage removed pipe if requested by the Engineer. Such pipe will remain the property of the Department. Store such pipe at a suitable location on or adjacent to the Project for transport by the Department.

202.03.3 Stockpile Suitable Excess Material for Later Use. If requested by the Engineer, stockpile suitable excess Material that cannot be immediately placed in fill areas for later use (Double handling is required).

A. Stockpile at a location within the Project limits as designated by the Engineer.

B. Load and haul, place, and compact stockpiled excess Material used in fill areas or for the formation of Embankments, shoulders and slopes.

C. These requirements also apply to excess Materials generated from bituminous pavement removal, incidental concrete removal, and all construction Materials that are suitable for fill Material.

D. Place or stockpile excess Materials suitable for Embankment purposes generated from other pay Items.

1. Place and compact Material if it can be immediately used in fill areas.

2. Stockpile and reuse at a later time if the Material cannot be immediately placed in fill areas.

E. Separately place or stockpile excess Material generated by others, including other Contractors or utility companies and their Contractors performing Work within the Limits of Construction.

202.03.4 Topsoil. Remove topsoil in its entirety from all cut sections and from fill sections where Embankment heights are less than 5 feet when measured vertically from bottom of fill to subgrade.

A. Stockpile topsoil to meet the requirements of Section 908.

B. Incorporate remaining topsoil in the outer portions of Embankment as shown in the Contract.

C. When Embankment needs are met, excess topsoil remains the property of the State:

1. Load State vehicles for its removal.

2. If the State grants ownership of excess topsoil to the Contractor, remove in accordance with Section 202.03.1.

202.03.5 Common Excavation. Excavate and place or dispose of otherwise unclassified material encountered during excavation.

202.03.6 Rock Excavation. Remove as rock excavation all material that cannot be excavated without blasting or using rippers. Include all boulders and detached stones with a volume of 1/2 cubic yard or greater. Excavate material classified as rock to a depth between 6 to 12 inches below subgrade. Shape the rock surface to drain. Backfill to subgrade as specified in Section 202.03.10.

A. *Blasting.* The Department will call a blasting conference at least fourteen (14) Calendar Days before any blasting. Prior to and for discussion at this conference, submit for approval blasting methods, schedule, and the required protection to ensure complete safety during blasting operations.

Assume responsibility for all damage due either directly or indirectly from the blasting operations. Excessive blasting or "over shooting" will not be tolerated. Remove and replace with approved backfill Material any material outside the limits shown on the Contract Documents that is shattered or loosened by blasting.

When drilling and blasting, exercise the necessary precautions to preserve the rock in the finished slope in a natural undamaged condition with surfaces remaining reasonably straight and clean. When the results of the blasting do not yield a natural undamaged condition, adjust operations to obtain the required slope conditions called for on the Contract Documents. Modify drilling and blasting procedures such as drill blast holes at the inclination of the finished slope, employ delayed blasting techniques, change the spacing of blast holes, or reduce the quantity of explosive.

Presplit rock slopes when specified. Plan diameter, spacing, and loading of presplitting holes to produce a neat break ensuring the resulting backslope face is unaffected by subsequent blasting and excavation operations. Drill presplitting holes to the full depth of the ledge.

Demonstrate to the Engineer with a 100 foot test section that diameter, spacing, and loading will produce an acceptable backslope. Continue presplitting if the backslope is acceptable. Establish test sections until satisfactory results are obtained.

Drill blasthole depth to the lesser of plan grade, or lifts of not more than 25 feet.

If drilling in benches, an offset not to exceed 18 inches will be permitted to accommodate the head of the drill. Extend pre-splitting at least 20 feet ahead of the limits of fragmentation blasting, unless otherwise directed. If the pre-splitting is unsatisfactory, make adjustments in the spacing, diameter, and loading of the pre-split holes using another 100 foot test section.

Schedule operations so that all rock excavation within a distance of 100 feet from Bridges or other large Structures is completed to the required slope lines and depths before all Structure work is started.

B. Remove as directed all loose and unstable material, breakage, and slices, even if located beyond the payment lines indicated on the Contract Documents as the excavation for each lift progresses.

C. Handle and load explosives according to the manufacturer's recommendations.

202.03.7 Borrow Excavation. Provide borrow Material, in accordance with Contract Documents, from outside of the Right-Of-Way or from outside excavation limits. Make arrangements and pay all costs involved in procuring borrow. Allow the Engineer to cross-section after stripping and before use. Furnish a certified hazardous waste site assessment for borrow areas located off the Right-Of-Way. Provide an alternate borrow source or conduct more detailed testing in suspect locations.

Use suitable and available common and rock excavation before using borrow Material.

Obtain approval to use borrow in lieu of on-site excavation. Grade borrow areas uniformly to drain.

202.03.8 Unsuitable Excavation. The Engineer will consider excavation unsuitable if it contains deposits of saturated or unsaturated soil mixtures or organic matter unacceptable for Embankment Material.

Remove unsuitable material encountered in the subgrade. Excavate to the specified depth or as directed by the Engineer. Backfill and compact with approved Material as specified in Section 202.03.10.

Dispose of material that cannot be properly stabilized and compacted as specified in Section 202.03.1.

202.03.9 Undercut Excavation.

A. *General.* This Work consists of excavation to correct unstable subgrades and Embankment foundations and the disposal of such excavated material.

B. *Materials.* All material removed in the work of undercut excavation will be classified unsuitable and shall be disposed of, unless otherwise directed.

C. *Equipment.* Use Equipment for undercutting and backfilling operations 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.

D. *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. Allow sufficient time to elapse to accurately judge the success of the preparation effort after performing these normal preparation procedures. 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.

E. *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. Before 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, backfill and compact the area in accordance with this Section, or

as directed. 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.

Rework any area remaining unstable after backfilling in accordance with this Section. When such rework is required, 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.

F. *Performance Requirements.* The correction of an unstable condition shall result in a firm, unyielding foundation.

202.03.10 Embankment Construction

A. *General*. Embankment construction includes preparing areas upon which Embankments are to be placed; placing and compacting approved Embankment Material within roadway areas to replace unsuitable material; and placing and compacting Embankment Material in cavities and other depressions within the roadway area.

1. *Haul Roads.* Do not construct any haul roads across State owned property or within the limits of the Contract unless approved in advance. Maintain haul roads for the duration of the Project. Remove haul roads, including all materials placed, at the end of the Project and restore area to its native condition. Haul roads will not be permitted through wetland areas which fall outside the Limits of Construction unless approved by the U.S. Army Corps of Engineers or the DNREC, or both, as applicable.

2. *Dust Control.* Adequately control dust, exclusively by water, at all times during the earth-moving operations.

3. *Stability.* Assume responsibility for the stability of Embankment. Replace Embankment that, in the Engineer's judgment, has been damaged or displaced due to the following: carelessness or negligence, natural causes such as storms and floods, shrinkage of Embankment Material, and all other reasons not attributable to movement of the natural ground upon which Embankment is placed.

Compact lifts in Embankment areas, other than rock, as specified below. The Department will perform compaction and/or moisture tests once the stability of the lift is tested by the Contractor per Section 202.03.10.J and approved by the Engineer. Compliance will be determined by the Department with field compaction tests performed in accordance with the following AASHTO test methods:

a. AASHTO T 191. Express field density tests as a percentage of the maximum density made on the same soils;

b. AASHTO T 99 Method C, Modified, for determination of maximum density and optimum moisture content;

i. Moisten or dry and thoroughly mix to the proper moisture content before compaction if the soil moisture content is not within 2 percent of optimum;

Do not use frozen Embankment Material or place Embankment Material on frozen ground. Do not place rocks, broken concrete, and other solid materials in Embankment areas designated for placing or driving piles.

B. *Equipment.* Provide sufficient Equipment to grade, level, and promptly compact after depositing Embankment Material. Cease placement of Material when the capacity of the grading and compacting Equipment is inadequate for the rate of compacting, excavation, or placing of Embankment.

1. Use approved rollers, compactors, or other suitable compaction Equipment provided all Equipment is configured and operated to meet the requirements specified.

C. *Preparation of Embankment Areas.* Remove unsuitable material before constructing Embankment.

Bench when placing Embankment on hillsides or against existing Embankment with slopes steeper than 6:1. Bench continuously in loose lifts no deeper than 8 inches loose measurement. Ensure benches can

accommodate placing and compacting Equipment. Begin all horizontal cuts at the intersection of the ground line and the vertical side of the previous bench. Step existing slopes to keep the Embankment from wedging against Structures. Compact excavation from benching with the new Embankment Material.

Where the height of the Embankment at the subgrade level is to be 5 feet or less, remove all organic matter from the existing ground surface. Scarify the cleared surface to a minimum depth of 6 inches. Compact to the specified Embankment density. Where the height of the Embankment is to be greater than 5 feet, disc all remaining sod thoroughly before constructing Embankment.

Scarify existing roadways containing granular material within 3 feet of the subgrade to a depth of 6 inches. Compact to the specified Embankment density.

D. *Placement*. Place Material in successive lifts; place each lift in a level, uniform cross-section no greater than 8 inches loose measurement, unless directed otherwise by the Engineer. Deposit and spread lifts across the full width of the Embankment, parallel to the roadway centerline. If required, disc each lift to ensure uniform distribution of moisture and component Materials. Properly compact each lift, as specified, before starting the next lift. Do not place Embankment on any wet, unstable, or frozen materials.

1. The Engineer may direct that the first lift of Embankment be placed at a depth greater than 8 inches loose measurement in specific Embankment areas when permitted by the soil conditions encountered. Place all subsequent lifts as specified above.

2. Proof roll all lifts of soil, aggregate, or soil mixtures according to the requirements of Section 202.03.10.J. Correct any instability evidenced during the proof roll by discing, aerating, recompacting, removing, or replacing the Material. After corrective measures, proof roll to verify the stability of the lift is as required.

3. At the end of each Day during Embankment placement construct edge berms, interceptor berms, and Embankment slopes as required. Extend temporary slope drains to connect to edge and interceptor berms.

E. *Embankment Adjacent to Structures.* Compact Embankment in accordance with Section 207.

F. *Existing Roadways.* Treat existing roadway surfaces lying less than 5 feet below the final grade as follows:

1. Scarify, to a depth of at least 6 inches of existing compacted unpaved road surfaces lying within 3 feet of the final grade, or within the Pavement Structure if the subgrade is more than 3 feet from the final grade unless otherwise designated on the Contract Documents. Recompact scarified Material.

2. Remove the underlying base materials and scarify, to a depth of 6 inches of existing bituminous surface treated and paved road surfaces lying within 5 feet of the final grade, or within the Pavement Structure if the subgrade is more than 5 feet from the final grade. Recompact scarified Material.

3. Existing roadway surfaces lying more than 5 feet below the final grade, or bottom of Pavement Structure may remain in place, provided that no bituminous material is left in place below the water table as determined by the Engineer or as shown in the Contract Documents.

4. Treat roadway surfaces to remain in place as follows:

   a. Break up bituminous concrete into pieces with a maximum surface area of 1 square foot and recompact.

   b. Break up Portland cement concrete into pieces with a maximum surface area of 1 square yard with a pavement breaker or other approved Equipment.

5. Scarify to a depth of 6 inches and re-compact bituminous surface treated roadways lying beneath Embankment.

G. *Roadway Embankment.* Place and spread roadway Embankment in uniform horizontal lifts no greater than 8 inches loose measurement. Compact to the specified density before placing the next lift. Requests to increase lift thickness shall be submitted to the Engineer for approval. Maintain proper moisture content to achieve the required density and stability.

H. *Rock Embankment.* Place rock Embankments in lifts equal to the average rock dimension. Restrict maximum rock dimension to 36 inches. Distribute spalls and finer rock fragments to level and smooth each lift. Place succeeding lifts to not damage previously completed lifts. Dump rock on the lift being constructed, and push into place. Do not construct rock lifts within 24 inches of finished subgrade.

Place at least 24 inches of compacted Embankment over Structures before placing rock. Drain pockets left in the surface of rock before backfilling.

I. *Preparation of Subgrade***.** Shape subgrade for its full width to required grade and cross section. Scarify the top 6 inches of the subgrade and increase or decrease moisture content to achieve the specified density and stability. Compact to maximum density to allow placement of base or surface course Material without rutting or displacing the roadbed. Scarify, dry, reshape, and re-compact Material if construction Equipment on Embankments causes movement, rutting, or displacement of the Material, and test for density and moisture requirements.

Provide and maintain temporary ditches from the cut for the Pavement Structure to the side ditches at intervals necessary to permit drainage of the subgrade. Provide and maintain all facilities necessary for complete drainage of the construction area. Provide sediment and erosion control measures for all water drained or pumped from the subgrade in accordance with Contract Documents.

Do not place subbase or base Materials until the subgrade has been approved by the Engineer.

The Engineer will determine maximum density according to AASHTO T 99 Method C Modified and in-place field density according to AASHTO T 191 or T 310.

Ensure the finished subgrade surface is smooth and conforms to prescribed elevations before constructing the base or surface course. Limit the maximum variation from the subgrade elevation to the prescribed elevation to plus or minus ½-inch.

Correct all finished sections damaged during construction operations at no cost to the Department.

1. *Cut Section.* Properly shape and uniformly and thoroughly compact the subgrade in conformity with the lines and grades shown on the Contract Documents or as established in the field and approved by the Engineer before placement of any subbase, base, or surfacing Material. Boulders, large rocks, muck, vegetation, or other materials that would prove detrimental to the stability of the roadway will not be permitted in the subgrade. Fill with suitable Material depressions that develop during the rolling re-roll; repeat until no depressions develop or remain in the subgrade.

    a. 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 202.03.8. Conduct operations so that the Engineer can take necessary cross-sectional measurements before the backfill is placed.

2. *Fill Section.* Before placement of any base Material, complete the subgrade and adjacent shoulder or slope rounding earthwork to finished grade elevation to form a box to retain the base Material. Do not place base Material in a section where a box is not complete unless specifically approved by the Engineer.

J. *Proof Rolling.* Perform proof rolling with a fully loaded, ten-wheel dump truck or other Equipment approved by the Engineer.

1. Acceptance of the proof roll by the Engineer is required before subsequent lifts can be placed.

2. No compaction tests will be taken until the stability of the lift is deemed stable by the Engineer.

3. Run the Equipment longitudinally until the unrolled area between tire strips is less than 18 inches.

4. Scarify, disc, aerate, or add moisture, and recompact the subgrade to the extent necessary to achieve stability when proof rolling shows the subgrade to be unstable.

K. *Compaction Procedure*. Start compaction or rolling at the edges, progress toward the center of the

Embankment. Continue compaction until each lift is thoroughly and uniformly compacted to the full width of the Embankment and to 95-percent or more of the maximum density of the same soils as determined by AASHTO T 99 Method C, Modified.

1. The ordinary use of trucks, carryalls, scrapers, tractors, or other construction Equipment may be considered as rolling as long as the traffic of hauling Equipment is evenly distributed over the fill to make the best use of the compaction provided by construction Equipment.
2. Build all areas of sharp depressions, trench backfills, and around Culverts, Bridges, and walls, inaccessible to the specified methods of compaction, in continuous uniform horizontal lifts no greater than 8 inches loose measurement. Compact to the specified density before placing the next lift.
3. Compact properly broken rock, bituminous Material, or Portland cement concrete with a minimum of six passes of an approved roller or as directed.

202.04 Method of Measurement.

The quantity of excavation will be measured by the cubic yard. The volume may be computed by the method of average end areas measured by cross-sections taken at regular intervals and at breaks in grade, comparison of surveyed electronic surfaces, or other means as approved by the Engineer. 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 in the stockpile.

Embankment will not be measured.

When Item 202000 is indicated in the Contract Documents as a fixed quantity, measurement and payment shall be in accordance with Section 109.05.

The quantity of undercut excavation will be measured in cubic yards 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 Section 202.03.9.D, will not qualify for measurement as undercut excavation.

The quantity of rock excavation for roadway and utility trenches will be measured in cubic yards. The volume of rock excavation will be measured to the limits of excavation shown on the Plans or as adjusted by the Engineer. Base the areas on cross-sections or topographical surveys performed before and after excavation. Rock excavated from depths in excess of 12 inches below the subgrade will not be measured. The Material used for backfilling the excavated areas will be measured under its appropriate Section, within the limits established by the Section.

Material used for plugging of existing pipes to be abandoned in place will not be measured.

Removal of pipe and underdrain, including removal below and outside the limits of excavation, regardless of depth will not be measured.

202.05 Basis of Payment.

The quantity of excavation will be paid for at the Contract Unit Price per cubic yard. Price and payment will constitute full compensation for the removal of all obstructions covered under Section 202.03.2 and within the Limits of Construction; for the placement of Embankments as specified under Section 202.03.10; 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 proof 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 other Sections will be paid for under Section 202. Undercutting of unsuitable material, as defined in this Section, will be paid for at the rate of 150 percent of the Unit Price per cubic yard.

The quantity of rock excavation will be paid for at the Contract Unit Price per cubic yard. Price and payment will constitute full compensation for drilling, blasting, and presplitting; for excavations, removing, backfilling, and compacting Materials within the area between the subgrade as shown on the Plans or adjusted by the Engineer and 12" 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 to complete the Work.

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 Contract Documents. No separate payment will be made for Materials used for the maintenance of haul roads.

Backfilling of voids created by excavation of Structures as defined by Section 202.03.2 shall be as directed by the Engineer.

Cost for stockpiling and double handling excess Material as outlined in Section 202.03.3 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 Section 202.03.3 will be paid for at the Contract Unit Price per cubic yard 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 908.

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.

The quantity of undercut excavation will be paid for at the Contract Unit Price per cubic yard. 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 Bid Price for undercut excavation, as defined herein, shall not exceed 150 percent of the Unit Bid Price per cubic yard for the Item excavation and embankment, where such Item is a Bid Item. Before 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 Section 202.3.9.D.

Payment for the Material used for plugging of existing pipes to be abandoned is incidental to Item 202000.

Payment for removal of pipe and underdrain including removal below and outside the limits of excavation, regardless of depth is incidental to Item 202000.

ITEM	DESCRIPTION	UNIT
202000	EXCAVATION AND EMBANKMENT	CY
202001	ROCK EXCAVATION FOR ROADWAY	CY

ITEM	DESCRIPTION	UNIT
202002	ROCK EXCAVATION FOR UTILITY TRENCHES	CY
202003	UNDERCUT EXCAVATION	CY
202004	UNDERCUT EXCAVATION, PATCHING	CY

SECTION 203 – CHANNEL EXCAVATION

203.01 Description.

Widen, deepen and/or realign existing stream channels and waterways; reconstruct channel and stream configurations and locations; and shape and finish channel and stream beds and stream banks and dispose of or utilize excavated material in accordance with Contract Documents and as directed by the Engineer.

203.02 Materials. Not applicable.

203.03 Construction.

A. Complete Work in conformance with Section 909.03.

B. Utilize excess suitable Material in Embankment or fill areas as specified in Section 202.03.10.

C. Dispose of unsuitable excavated material as specified in Section 106.08.

203.04 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 basis, by the average end area method between the limits shown in the Contract Documents. Measurement will not include Material removed outside the payment limits, unless such Work is directed by the Engineer.

203.05 Basis of Payment.

The quantity of channel excavation is paid at the Contract Unit Price per cubic yard. Price and payment shall constitute full compensation for excavating, hauling, depositing, and grading of excavated Materials; shaping and finishing of channel and stream beds and stream banks; embanking excess suitable Material; disposing of excess and unsuitable Materials; and for all labor, Equipment, tools, and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
203000	CHANNEL EXCAVATION	CY

SECTION 204 - TEST HOLES

204.01 Description.

Excavate test holes at points of possible utility conflicts to determine if a conflict exists. Coordinate conflicts with the Engineer and the utility company involved. The Engineer will ultimately determine the solution to the utility conflict. This Work does not relieve the Contractor of the responsibility to locate underground facilities as required under Section 105.09.

204.02 Materials. Not applicable.

204.03 Construction.

A. Establish sufficient limits of excavation to determine existing underground utility type, size and condition;

B. Excavate and backfill test holes using Equipment approved by the Engineer.

1. Prevent damage to wrappings, coatings or other protective coverings by hand digging, vacuum excavation or use of similar non-destructive locating Equipment.

204.04 Method of Measurement.

The quantity of test holes will be measured on a cubic yard basis.

204.05 Basis of Payment.

The quantity of test holes will be paid for at the Contract Unit Price per cubic yard. Price and payment constitute will full compensation for furnishing all labor, Materials and Equipment necessary to excavate and backfill the test holes.

ITEM	DESCRIPTION	UNIT
204000	TEST HOLE	CY

SECTION 207 – STRUCTURAL EXCAVATION AND BACKFILL

207.01 Description.

Excavate, haul, dispose of, place and compact specified Materials necessary to construct Structures. Furnish and install sheeting and bracing to stabilize excavations. Dewater the Work area as necessary.

207.02 Material. Provide Materials as specified in:

Borrow	Section 209; Section 1001

207.03 Construction.

A. Structural Excavation

1. Excavate sufficient volume to place the full width, length and depth of any foundation elements and foundation stabilization.
2. Handle excavated Material as specified in Section 202.03. Dispose of all unsuitable Material and other obstructions as specified in Section 106.08.
3. As necessary, remove unsuitable Material below the elevation of the foundation stabilization as extra depth excavation.
4. When excavation is completed, the Engineer will inspect the footing area. Do not place concrete or precast units until the depth and character of the foundation Material are approved.

B. Shoring

1. Provide shoring as specified in Section 604.03.5 & Section 604.03.6 or a 2:1 cut slope for all excavations at 5 foot depth and greater, and when required by OSHA standards or other applicable safety regulations.
2. Remove all temporary shoring and bracing upon completion of the Work, unless otherwise noted on Contract Plans. Submit formal request, for approval by the Engineer, if shoring and bracing is to be requested to remain in place.

C. Rock Excavation for Structures

1. Remove Material in accordance with Section 202.03.6.

D. Backfill

1. Place and spread backfill Material in uniform horizontal lifts no greater than 8 inches loose measurement. Compact to the specified density before placing the next lift. Requests to increase lift thickness shall be submitted to the Engineer for approval. Maintain proper moisture content to achieve the required density.
2. Compact backfill Material without applying excessive pressure against Structures. Place fill adjacent to the end bent of a Bridge only to the bottom of the backwall until the superstructure is in place. Place backfill on each side of the Structural unit simultaneously to proposed grades so that no unbalanced stresses are introduced on the Structure.
3. When backfilling next to or over Structures, do not use heavy mechanical compacting Equipment until a minimum of 18 inches of cover has been placed over the Structural unit.

207.04 Method of Measurement.

A. Structural Excavation: The quantity will be measured in cubic yards of Material excavated within the payment limits. The volume will be limited by vertical planes located 24 inches outside of the neat line perimeter of the vertical faces of the Structural element. Within these plan limits, the upper limit will be the lowest combination of the existing ground surface, bottom of roadway excavation, bottom of channel

excavation and excavation incidental to Removal of Structures and Obstructions. The lower limit will be the bottom of the foundation stabilization.

Excavation of Material outside the plan limits will not be measured, unless such Work is directed by the Engineer.

Extra depth excavation will be measured in cubic yards of Material excavated below the lower limit of Structural excavation and within the plan limits described above.

B. Rock Excavation: The quantity will be measured in cubic yards where encountered within the Structural excavation limits.

C. Structural Backfill: The quantity will be measured in cubic yards of Material placed and accepted within the payment limits. The volume will be limited by vertical planes located 24 inches outside of the neat line perimeter of the vertical faces of the Structural element. Within these plan view limits, the upper limit will be finished grades minus depth of riprap or pavement. The lower limit will be the top surface of the foundation stabilization and the Structural units.

Where these limits overlap the limits from Removal of Structures and Obstructions, as defined per Section 211, measure the backfill limits described within this Section. Backfill Material outside the plan view limits will not be measured, unless such Work is directed by the Engineer.

D. Temporary Shoring and Bracing: The quantity will not be measured.

207.05 Basis of Payment.

Price and payment for structural or rock excavation constitutes full compensation for excavating, hauling, and disposal of excavated materials; for placing shoring and bracing; for dewatering the work area; and for all labor, Equipment, tools, and incidentals required to complete the Work.

Price and payment for structural backfill constitutes full compensation for furnishing, placing and compacting backfill; and for all labor, Equipment, tools, and incidentals required to complete the Work.

The quantity of Structural excavation, rock excavation and Structural backfill will be paid at the Contract Unit Price per cubic yard. Price and payment constitutes full compensation for excavating, hauling, and disposal of excavated Materials; for furnishing, placing and compacting backfill; for placing shoring and bracing; for dewatering the Work area; and for all labor, Equipment, tools, and incidentals required to complete the Work.

No payment will be made for temporary shoring and bracing left in place.

No payment will be made for Material excavated or backfill placed outside of the payment limits unless the Engineer requires extra depth excavation due to poor soils. If the Engineer requires extra depth excavation, follow the pay limits provided in Table 207-A below.

TABLE 207-A

Depth Lowered		**Additional Percent**
More Than (feet)	**Not Over (feet)**	
0	5	25
5	8	60
8	10	100

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 Section for excavating to depths below those shown on the Plans.

ITEM	DESCRIPTION	UNIT
207000	STRUCTURAL EXCAVATION	CY
207010	ROCK EXCAVATION FOR STRUCTURES	CY
207020	STRUCTURAL BACKFILL (BORROW TYPE B)	CY
207021	STRUCTURAL BACKFILL (BORROW TYPE C)	CY

SECTION 208 - FLOWABLE FILL

208.01 Description. Furnish and place flowable fill Material at locations as specified in the Plans and as directed by the Engineer.

208.02 Materials. Provide Materials as specified in and as follows:

Flowable Fill	Section 1047

A. Flowable fill consists of a combination of Portland cement, fine aggregate, water, air entraining admixtures, chemical admixtures, and/or ground granulated blast furnace slag, fly ash.

B. Submit sources of all Materials to the Engineer a minimum of 30 Days prior to use.

C. Submit Material test data of fly ash representative of the source to the Engineer a minimum of 30 Days prior to use. Include test data characteristics of the ash leachate as determined by the Toxicity Characteristics Leaching Procedure (TCLP) in accordance with EPA SW-846, with respect to leachate metals.

208.03 Construction.

208.03.1 Mix Design. Prepare and submit a mix design a minimum of 30 Days in advance of use.

A. Design the Material to produce a 28-day compressive strength of 50 to 200 pounds per square inch. While not required, the addition of an accelerator may be allowed if early gain in strength is desirable.

B. Test compressive strength in accordance with the following AASHTO test methods:

1. AASHTO T 106 Compressive Strength of Hydraulic Cement
2. AASHTO T 23, Making and Curing Concrete Test Specimens in the Field.

208.03.2 Plant and Equipment Requirements. Provide flowable fill produced only in batching plants meeting the requirements of Section 1022 – Concrete Production.

208.03.3 Transportation. Transport flowable fill to the project in ready-mix trucks or as approved by the Engineer. Place the Material within three hours of the introduction of water to the mixture.

208.03.4 Placement. Place flowable fill only when:

A. The ambient temperature is a minimum of 40 degrees Fahrenheit and rising;

B. The temperature of the flowable fill is a minimum of 50 degrees Fahrenheit;

C. Do not place flowable fill against frozen surfaces;

D. Protect flowable fill from freezing for at least 36 hours in accordance with Section 501.03.6;

E. Provide positive containment of the fill Material to prevent flow beyond the desired placement location;

F. Discharge fill at a rate that allows the Material to:

1. flow into the placement location;
2. fill all voids; and
3. not dislodge the existing containment or interior items.

G. Make relief holes wherever necessary to ensure that all voids are filled.

Ensure that all interior items are capable of withstanding the lateral hydraulic pressures of the flowable fill. Do not exceed 5 feet in lift thickness unless otherwise directed by the Engineer. Allow each lift to cure until it is self-supporting before placing additional lifts or other loads.

Take care to prevent pipes from floating with the use of straps, soil anchors, or other approved means of restraint that may be required to ensure proper alignment when flowable fill is used as backfill for pipes. Ensuring proper alignment is the sole responsibility of the Contractor.

Place flowable fill to the final lines and grades shown on the Plans. Maintain all confining and supporting Structures, protective covers, and barriers until the flowable fill is self-supporting. Shrinkage of the flowable fill as it cures may require additional backfill with other Material.

Protect flowable fill from direct contact with vehicular traffic and from prolonged exposure to rain and or running water.

208.04 Method of Measurement.

The quantity of flowable fill will be the measured number of cubic yards of material accepted and placed within the approved limits of the fill location. Pipe trenches will be measured in accordance with Section 207.04.

208.05 Basis of Payment.

The quantity of flowable fill will be paid for at the Contract Unit Price per cubic yard. Price and payment will constitute full compensation for furnishing component Materials, designing, mixing, and hauling the fill Material; preparing the fill location for containment of the fill Material; anchoring of items within the fill location; protecting and curing the Material after placement; and all labor, tools, Equipment and incidentals necessary to complete this Work.

ITEM	DESCRIPTION	UNIT
208000	FLOWABLE FILL	CY

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 includes all clearing, grubbing, or stripping required to prepare the borrow area for cross-sectioning and excavating. This Work also consists of furnishing borrow for use as backfill in utility trenches.

209.02 Materials. Provide Materials as specified in:

Borrow	Section 1001

209.03 Construction.

209.03.1 Borrow Sources. Notify the Department's Materials and Research Section at least ten (10) Working Days in advance of Material being removed from any borrow source so that samples may be obtained and tested prior to use. Submit for approval by the Department's Materials and Research Section, the limits of the approved Material within the borrow source and the method of excavation. Clear and grub the ground surface in the manner described in Section 201 and strip of all unsuitable material, as determined by the Engineer, before the excavation of any borrow. Excavation of borrow within 100 feet of the right-of-way lines is not permitted, except with written permission from the Engineer.

Secure any borrow source that is tested, approved and cross-sectioned for excavation by means of physical control. The method of control is dependent on the conditions at the source, but may consist of complete or partial fencing, earth berms, guardrails, or other physical barriers. Provide secure access at the entrance to the borrow source with a gate, chain, cable or other acceptable device and secure by padlock. The key to the padlock will be retained by the Department, once the security method is approved.

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. Upon completion of excavation, trim and leave the borrow area in a neat condition to permit accurate measurement. Water is not permitted to collect or stand within the excavated borrow area, where practicable.

209.03.2 Source Testing. The Department will assist the Contractor in determining the quality and quantity of Material from sources the Contractor proposes to use. The Department will perform soil analysis tests on one boring for each 500 cubic yards of borrow.

209.03.3 Placing and Compacting. All borrow under this Section shall be placed and compacted in accordance with the requirements of Section 202.03.10.

209.03.4 Pipe and Utility Backfill. For pipe and utility trenches within the roadway, backfill with Material conforming to the requirements of Section 1001, Borrow Type C. Use existing Material for backfill if it meets the requirements of Section 1001, Borrow Type C. For these areas, backfill Material to a compaction of 95-percent or more of the maximum density according to the requirements of Section 202.03.10. Backfill pipe and utility trenches outside the roadway with Material conforming to the requirements of Section 1001, Borrow Type C, to a height of 12 inches above the top of the pipe or utility, unless directed otherwise. Backfill the remaining depth of these trenches with existing Material, unless otherwise directed. For these areas, backfill Material to a compaction of 95 percent or more of the maximum density according to the requirements of Section 202.03.10.

Furnish backfill Material for pipe and utility trenches. Stockpile Materials at location(s) mutually agreed upon by the Contractor, the utility, and the Engineer.

Coordinate with the utility organizations the operation of backfilling utility trenches. Backfilling utility trenches is to be performed by the respective utility organizations involved and in conformance to the requirements of Section 202.03.10 except proof rolling will not be required.

Utility companies will be required to remove all excess excavation Material directly related to the utility trenching from the Project, unless the Engineer directs it to be used by the Contractor as part of the Project.

209.04 Method of Measurement. For all sizes, the quantity for pipe and utility borrow Material 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 placement, and a normal horizontal measurement outside of the pipe or utility dimension plus a neat line 18 inches each side, excluding rock excavation.

The quantity of borrow Material will be measured in cubic yards 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, may alternatively be weighed and the weight converted to cubic yards. 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, 3050 pounds of borrow will be considered equivalent to one cubic yard.

Unless stated otherwise, all borrow Material that is to be measured by weight shall be calculated as specified in Section 109.01.

209.05 Basis of Payment. The quantity of borrow will be paid for at the Contract Unit Price per cubic yard. 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. Placing and compacting the borrow Material are not included in the furnishing borrow for pipe and utility trench Items as that responsibility will be on the respective utility company.

ITEM	DESCRIPTION	UNIT
209001	BORROW, TYPE A	CY
209002	BORROW, TYPE B	CY
209003	FURNISHING BORROW, TYPE B FOR PIPE AND UTILITY TRENCH BACKFILL	CY
209004	BORROW, TYPE C	CY
209005	FURNISHING BORROW, TYPE C FOR PIPE AND UTILITY TRENCH BACKFILL	CY
209006	BORROW, TYPE F	CY
209007	BORROW, TYPE A	TON
209008	BORROW, TYPE B	TON
209009	BORROW, TYPE C	TON
209010	BORROW, TYPE F	TON

SECTION 211 - REMOVAL OF STRUCTURES AND OBSTRUCTIONS AND EXISTING PORTLAND CEMENT CONCRETE PAVEMENT, CURB, AND SIDEWALK

211.01 Description.

Raze, remove, dispose of, or salvage: buildings; foundations; fences; Structures; guardrail; abandoned pipelines or utilities; existing Portland cement concrete pavement, curb and sidewalk and other obstructions designated for removal except for Items removed and disposed of under other Sections of these Specifications. Backfill resulting cavities in accordance with the Contract Documents.

211.02 Material. Provide Materials as specified in:

Borrow	Section 1001

211.03 Construction.

211.03.1 General. Raze, remove, salvage, or dispose of Material promptly. Dispose of Material as specified in Section 202.03.2. Complete blasting and other operations that may damage new construction before constructing new Work. When backfilling cavities within the proposed roadway box, utilize Borrow Type C. When backfilling cavities outside of the proposed roadway box, utilize Borrow Type F.

Saw cut concrete pavement, sidewalks, curbs, gutters, and similar Structures that will be left in place to a true vertical line or remove to an existing joint in accordance with Section 762.

211.03.2 Removal of Bridges, Culverts, and Other Drainage Structures. Do not remove Bridges, Culverts, and other drainage Structures until satisfactory arrangements have been made to accommodate traffic and the delivery of construction Materials.

Remove existing Structures in their entirety except for deep foundations. Remove deep foundations to 24 inches below proposed ground surface elevation.

211.03.3 Removal of Fences and Guardrail. Carefully remove fences and guardrail within the Limits of Construction, as specified in the Contract Documents.

211.03.4 Removal of existing Portland cement concrete pavement, curb and sidewalk. Remove all existing Portland cement concrete pavement, curb and sidewalk necessary to complete the Work. Obtain approval from the Engineer of type of power breaking machines or other Equipment intended to be used. A ball type breaker machine is not permitted. Do not break more than can be removed in a given day without approval from the Engineer. Ensure no damage occurs to the subbase and any existing buried, surface or aerial utility.

211.03.5 Disposal. Dispose of excess or waste Material as specified in Section 106.08.

211.04 Method of Measurement.

The Engineer will measure Work acceptably completed as specified in Section 109.01 and as follows:

Perform and complete all Work under this Section before cross-sections are taken in accordance with Section 202.04.

No measurement will be made if the Contract Item stipulates the Contract Pay Unit is lump sum.

If the Contract Item is on a unit basis, the Engineer will measure the quantity of Structures and Obstructions acceptably removed.

Pay limits for removal are the difference in elevation between the existing ground surface or the bottom of roadway excavation, whichever is lower, and the bottom of the existing Structure and to the vertical planes 24 inches outside of the neat line of the existing Structure.

Borrow and backfilling operations will not be measured or paid.

The quantity of removed existing Portland cement concrete pavement, curb, and sidewalk will be measured in square yards along the top surface of the Materials to be removed, as projected on the horizontal plane.

211.05 Basis of Payment.

The Department will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
211000	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS
211001	REMOVAL OF PORTLAND CEMENT CONCRETE PAVEMENT, CURB AND SIDEWALK	SY

Price and payment will constitute full compensation for furnishing all Materials, Equipment, labor, and incidentals to removing and disposing of Structures and obstructions, existing Portland cement concrete pavement, curb and sidewalk and other obstructions designated for removal. The Department will not make separate payment for excavating, backfilling, and compacting cavities resulting from the removal of Structures or salvaging, storing, and protecting Materials in the Right-of-Way.

DIVISION 300 BASES

SECTION 301 - GRADED AGGREGATE BASE COURSE

301.01 Description.

Construct Graded Aggregate Base Course (GABC) on a prepared sub grade or base.

301.02 Materials. Provide Materials as specified in:

Graded Aggregate	Section 1005
Coarse Aggregate	Section 1004

301.03 Construction.

Sub Grade Preparation. Shape to grade and cross section shown on the Plans and in accordance with Section 202.03.10.I.

Equipment. Place Material so that no segregation occurs. Use a water sprinkling device and rollers or compactors.

Spreading and Compacting. Place graded aggregate Material in successive layers, with a maximum layer thickness of 8 inches in depth loose measurement to prevent segregation and with a maximum surface deviation of 1/2 inch in 10 feet.

Compact each layer to 98 percent or more of the laboratory maximum density in accordance with AASHTO T99.

301.04 Method of Measurement.

The quantity of GABC will be measured as the actual number of cubic yards or tons, as specified in the Contract Documents, for stone placed and accepted. The weight will be determined according to Section 109.01

Refer to the Department's Material Average Weight Chart for conversion factors from cubic yard to tons for the respective Material.

301.05 Basis of Payment.

GABC is paid at the Contract Unit Price per cubic yard or ton for preparing, furnishing, hauling, placing, and compacting all Materials, and for all labor, Equipment, tools, and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
301001	GRADED AGGREGATE BASE COURSE, TYPE B	CY
301002	GRADED AGGREGATE BASE COURSE, TYPE B, PATCHING	CY
301003	GRADED AGGREGATE BASE COURSE, TYPE B	TON
301004	GRADED AGGREGATE BASE COURSE, TYPE B, PATCHING	TON
301005	RECYCLED P.C.C. BASE COURSE	CY
301006	RECYCLED ASPHALT PAVEMENT	CY
301007	RECYCLED P.C.C. BASE COURSE	TON
301008	RECYCLED ASPHALT PAVEMENT	TON

SECTION 302 - STONE

302.01 Description. Furnish, haul, place, and compact stone, in accordance with the Contract Documents and/or as directed by the Engineer.

302.02 Materials. Provide Materials as specified in:

Fine Aggregate	Section 1003
Coarse Aggregate	Section 1004

302.03 Construction.

302.03.1 Sub Grade Preparation. Shape to grade and cross section shown on the Plans in accordance with Section 202.03.10.I.

302.03.2 Equipment. Place Material so that no segregation occurs. Use rollers or compactors.

302.03.3 Spreading and Compacting. Place stone in successive layers, with a maximum layer thickness of 8 inches in depth, loose measurement to prevent segregation.

Compact each layer to 98-percent or more of the laboratory maximum density in accordance with AASHTO T99 Method C, Modified.

302.03.4 Removal of Temporary Construction. Remove and dispose of stone used in a temporary situation as directed by the Engineer.

302.04 Method of Measurement. The quantity of stone will be measured as the actual number of tons for stone placed and accepted. The weight will be determined according to Section 109.01.

302.05 Basis of Payment. The quantity of stone is paid for at the Contract Unit Price per ton. Price and payment constitutes full compensation for furnishing, hauling, and placing all Materials, and for all labor, Equipment, tools, and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
302001	DELAWARE NO. 2 STONE	TON
302002	DELAWARE NO. 3 STONE	TON
302003	DELAWARE NO. 8 STONE	TON
302004	DELAWARE NO. 10 STONE	TON
302005	DELAWARE NO. 57 STONE	TON

DIVISION 400 – BITUMINOUS MATERIALS

SECTION 401 – BITUMINOUS PAVEMENT

401.01 Description.

Construct one or more courses of bituminous pavement on either a prepared foundation or an existing surface course. Construct butt joints by saw cutting and removing the existing hot-laid bituminous concrete or Portland cement concrete pavement to provide an area to butt the new hot-laid bituminous concrete pavement against the existing pavement.

401.02 Materials.

Provide Materials as specified in:

Asphalt Cement	Section 1012
Asphalt Production	Section 1014
Tack Coat*	Section 1011
	* For Thin-Lift items: PG64-22
Release Agents	Section 1010
Joint Sealant	Section 1042

401.03 Construction.

Prior to paving, conduct a pre-paving meeting to discuss joint layout, Material delivery, striping layout, maintenance of traffic for paving, and Equipment. Include the Engineer, the Department's Materials and Research Section, and any other pertinent parties.

A. *Mix Design.* Develop job-mix formula (JMF) in accordance with Section 1014 Asphalt Production and submit test results for review a minimum of three (3) Days before application. Include aggregate type and gradation and percentages of polymer-modified emulsion, water, and cement by dry aggregate weight (mass).

B. *Delivery of Mixture.* Minimum of 100 tons per hour delivered to the Project site.

C. *Hauling Equipment.* Furnish trucks with 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. Provide each truck with a securely fastened cover of canvas or other suitable waterproof material that covers the bed from front to back and over the sides. Fasten the front of the tarp securely to the body or protected by an air foil. Provide 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. Do not remove any loads 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.

D. *Paver.* Self-propelled unit with automated screed or strike-off assembly that automatically controls grade leveling and slope, heated, and capable of spreading and finishing bituminous pavement Materials in lane widths specified. Equip with an attachment that confines the Material at the end of the gate and extrudes the asphalt Material in such a way results in a compacted wedge shape pavement edge (safety edge) of 32 degrees (+/- 2 degrees). Stopping the paver unit so that the attachment can be adjusted at cross roads, driveways, and obstructions is not permitted.

E. *Rollers.* Self-propelled, static and/or vibratory steel wheel type equipped with scrapers, or pneumatic-tire oscillating type, equipped with smooth tires of equal size and diameter with a system for moistening each wheel or roller. Use number and weight of rollers sufficient to compact the mixture to the required density without crushing aggregate or displacing the mixture.

F. *Weather Limitations.* Place bituminous pavement Materials only when the surface is dry, unfrozen, and the weather is not foggy or rainy. Presence of frost particles in the roadbed or on the surface is sufficient evidence

to prohibit placement.

Do not permit placement of subsequent lifts or release open to traffic until the mat temperature is below 140 degrees Fahrenheit.

Placement of bituminous concrete is not permitted when the ambient air temperature at the location of the paving operation is below the temperatures indicated in Table 401-A below:

Table 401-A. Minimum Ambient Air Temperature for Placement of Types of Bituminous Concrete

Material Type	1″ Lift or Less	1.25 to 2" Lift	Greater than 2.25 to 3” Lift
B	50 °F	40 °F	32 °F
C	50 °F	40 °F	N/A

G. *Preparing Base or Existing Surface.* Clear surface of debris. Apply and cure tack coat before placing the mixture. Apply a tack coat on all curbs, gutters, manholes, or other structure surfaces that will be in contact with the mixture.

Repair damaged areas of the tacked surface, and restore the existing pavement or base to a uniform grade and cross section before placing the mix.

H. *Tack Coat.* Apply on all dry and broom cleaned surfaces at a uniform rate of 0.05 gallons per square yard to 0.15 gallons per square yard at a temperature of 70 degrees Fahrenheit to 160 degrees Fahrenheit using pressurized distributing Equipment with a spray bar or other approved distribution system. Apply in advance of the asphalt paving operation, but no further than is anticipated for the current day's operation.

I. *Placement.* Place mixture in a continuous operation by paving machine methods of spreading and screeding to the thickness shown in the Contract Documents and conform to the grade and surface contour required.

1. Outside edges of pavement are to be in true alignment, parallel to the centerline of the roadway with the longitudinal joint in the surface course at the lane line.

2. When paving multiple lifts or courses, offset individual successive lifts a minimum of 6 inches.

3. Place the base course with an approved paver or spreader in approximately equal layers of not less than 3 inches and not to exceed 6 inches in depth after compaction. Submit for approval requests, if any, to use Type B Superpave in lieu of BCBC. If approved by the Engineer, the Type B Superpave may be placed in lifts of not less than 3 inches and not to exceed 6 inches in depth after compaction.

   The Type B Superpave placed in lieu of BCBC will be paid at the Contract Unit Price for BCBC and the Asphalt Cement Cost Adjustment will be based on the virgin asphalt of BCBC, not the Type B Superpave.

   After the bituminous concrete base course is placed, exposure is not permitted for a period longer than ten days. If, due to conditions of emergency, more than ten (10) Days elapse, uniformly spray a fog coat of CSS-l-h on the exposed base course before placing the wearing course of 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.

4. Carefully plan the placement of the surface course to ensure that the joints in the surface course will correspond with the proposed traffic lanes and will not be located in the wheel path of vehicles using the roadway. Locate longitudinal joints at the lane line (center and edge). Longitudinal joints must also be parallel to the centerline unless otherwise shown on the Plans. Place the longitudinal joint between the travel way and shoulder on the shoulder side of the lane line. Establish and follow reference lines or other approved markings to control the true alignment of the longitudinal joints.

Take immediate action to correct unsatisfactory Work should unevenness of texture, tearing, or shoving occur during the paving operation due to unsatisfactory Material, methods, or Equipment.

J. *Compaction.* Compact by rolling after the bituminous pavement mixture has been spread, struck off, and surface irregularities adjusted.

K. *Compaction Testing.* Perform Quality Control of pavement compaction by testing in-place pavement density. At the option of the Contractor, a single core on the first day of paving and after the change of a JMF may be required for laboratory testing for gauge calibration. Repair all core holes in accordance with 401699 Appendix A.

Engineer will perform Quality Assurance testing per 401699.

L. Material production quality evaluated per item 401699 - Quality Control/Quality Assurance of Bituminous Concrete .03 (a) Material Production - Tests and Evaluations.

Compaction quality evaluated per Item 401699 - Quality Assurance of Bituminous Concrete .03 (b) Pavement Construction - Tests and Evaluations.

M. *Joints.* Seal all newly created pavement joints that will not be overlaid, with the exception of those created from placement of newly laid adjacent passes, with an approved joint sealant Material of appropriate dimensions in accordance with the Contract Documents. Construct joints to ensure surface and compaction requirements are met. Tack all vertical contact surfaces before placing any new mixture against the joint. For joint openings exceeding 1/4 inch width, the Engineer may require corrective action at no expense to the Department.

1. For butt joints, saw cut and construct in accordance with Section 762 of the Contract Documents. Fill any saw cut beyond the limits shown on the Plans with approved sealant. Dispose of all Material removed for construction of the butt joint in accordance with Section 106.08.

N. *Surface Tolerances.* Maximum deviation both longitudinal and transverse is 1/4 inch in 10 feet. Correct or remove areas exceeding these tolerances at no expense to the Department.

401.04 Method of Measurement.

The Engineer will measure the bituminous pavement Materials acceptably placed as specified in Section 109.01.

The quantity of the safety edge will not be measured.

401.05 Basis of Payment.

Payment will be for the accepted quantity of bituminous pavement Materials at the Contract Unit Price per ton for furnishing, preparing, hauling, and placing all Materials, including tack coat and safety edge; for removing Material from around manholes, drainage inlets, valves, and similar features; for removing and replacing excess asphalt cement; and for all labor, Equipment, tools, and incidentals required to complete the Work.

Adjustments to payment will be made in accordance with Special Provision 401699.

The quantity of the safety edge is incidental to the respective paving Item.

ITEM	DESCRIPTION	UNIT
401001	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 115 GYRATIONS, PG 64-22 (CARBONATE STONE)	TON
401002	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 64-22 (CARBONATE STONE)	TON
401003	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 70-22 (CARBONATE STONE)	TON
401004	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 76-22 (CARBONATE STONE)	TON
401010	BITUMINOUS CONCRETE, SUPERPAVE, TYPE B, 115 GYRATIONS, PG 64-22	TON
401011	BITUMINOUS CONCRETE, SUPERPAVE, TYPE B, 160 GYRATIONS, PG 64-22	TON
401012	BITUMINOUS CONCRETE, SUPERPAVE, TYPE B, 160 GYRATIONS, PG 70-22	TON
401013	BITUMINOUS CONCRETE, SUPERPAVE, TYPE B, 160 GYRATIONS, PG 76-22	TON

401019	BITUMINOUS CONCRETE, SUPERPAVE, BITUMINOUS CONCRETE BASE COURSE, 115 GYRATIONS, PG 64-22	TON
401020	BITUMINOUS CONCRETE, SUPERPAVE, BITUMINOUS CONCRETE BASE COURSE, 160 GYRATIONS, PG 64-22	TON
401026	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 64-22, PATCHING	TON
401027	BITUMINOUS CONCRETE, SUPERPAVE, TYPE B, 160 GYRATIONS, PG 64-22, PATCHING	TON
401028	BITUMINOUS CONCRETE, SUPERPAVE, BITUMINOUS CONCRETE BASE COURSE, 160 GYRATIONS, PG 64-22, PATCHING	TON
401034	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG-64-22, WEDGE	TON
401035	BITUMINOUS CONCRETE, SUPERPAVE, TYPE B, 160 GYRATIONS, PG-64-22, WEDGE	TON
401041	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 64-22, (NON-CARBONATE STONE)	TON
401042	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 70-22, (NON-CARBONATE STONE)	TON
401043	BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 76-22, (NON-CARBONATE STONE)	TON
401049	THIN BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 115 GYRATIONS, PG 64-22	TON
401050	THIN BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 64-22	TON
401051	THIN BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 70-22	TON
401052	THIN BITUMINOUS CONCRETE, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 76-22	TON

SECTION 402 – BITUMINOUS PAVEMENT MATERIALS, PATCHING

402.01 Description.

Patch Portland cement concrete and bituminous pavement with bituminous pavement Materials.

402.02 Materials.

Provide Materials as specified in:

Asphalt Cement	Section 1012
Asphalt Production	Section 1014
Graded Aggregate Base Course	Section 1005
Recycled Asphalt Pavement (RAP)	Section 1014
Recycled Concrete Aggregate (RCA)	Section 1014
Joint Sealant	Section 1042

402.03 Construction.

Perform operations in accordance with Section 301 Graded Aggregate Base Course and Section 401 Bituminous Pavements.

Saw cut pavement using a cutting machine capable of cutting a groove in a straight line to the required depth to allow removal of Material without damage to adjacent pavement.

Apply perimeter joint seal, per Standard Construction Details, if there is no overlay over patch.

402.04 Method of Measurement.

The quantity will be measured at the actual square yard per inch thickness of bituminous pavement patching Materials placed and accepted. Width will be measured from outside of the completed patches as constructed; length will be the actual length measured along the centerline of pavement; depth will be measured from patch surface to top of subgrade.

Joint sealant will be measured for payment in accordance with Section 504.

402.05 Basis of Payment.

Payment for bituminous pavement patching Materials is at the Contract Unit Price per square yard per inch of thickness and constitutes full compensation for removal and disposal of existing materials, for preparing the sub grade, and for all labor, Equipment, tools, and incidentals required to complete the Work.

Furnishing, hauling, and placing bituminous pavement Materials and graded aggregate base course will be paid under Sections 401 and 301 respectively.

Excavation of unsuitable material will be paid under Section 202.

Saw cutting Portland cement and bituminous concrete pavement will be paid in accordance with Section 762.

Joint sealing will be paid in accordance with Section 504.

ITEM	DESCRIPTION	UNIT
402000	BITUMINOUS CONCRETE PATCHING	SY-IN

SECTION 403 – BITUMINOUS PAVEMENT MATERIALS FOR TEMPORARY ROADWAY MATERIAL (TRM)

403.01 Description.

Furnish and place bituminous pavement Materials as temporary roadway Material (TRM).

403.02 Materials.

Provide Materials as specified in:

Cold Patch	Section 1015
Asphalt Cement	Section 1012

403.03 Construction.

Coordinate repair of the existing pavement and the placement of TRM with all other Work and operations necessary to maintain traffic safely.

403.04 Method of Measurement.

The quantity will be measured at the placed tons of TRM calculated per Section 109.01 and accepted.

403.05 Basis of Payment.

Payment for TRM is as the Contract Unit Price per ton and constitutes full compensation for furnishing, preparing, hauling, placing, and removing all Materials and for all labor, Equipment, tools, and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
403000	BITUMINOUS CONCRETE AND/OR COLD-LAID BITUMINOUS CONCRETE (TRM)	TON

DIVISION 500 – RIGID PAVEMENT

SECTION 501 - PORTLAND CEMENT CONCRETE PAVEMENT (PCCP)

501.01 Description.

Construct a Portland cement concrete pavement (PCCP) on a prepared subgrade or base course.

501.02 Materials.

Provide Materials as specified below:

Portland Cement	Section 1022
Ground Granulated Blast Furnace Slag (GGBFS)	Section 1020
Fly Ash	Section 1020
Fine Aggregate	Section 1003
Coarse Aggregate	Section 1004
Air-Entraining Admixtures	Section 1022
Chemical Admixtures	Section 1022
Water	Section 1021
Curing Materials	Section 1022
Reinforcing Steel	Section 611 & Section 1037
Embedded Hardware:	
Load-Transfer Devices	Section 1037
Tie Bars	Section 1037
Coated Dowel Bars	Section 1037
Tie Bolts (Hook Bolts and/or W-Bolts)	Section 1037
Insulation Materials	Section 610.03.D.3.d

501.03 Construction.

Provide an American Concrete Institute (ACI) or National Ready Mix Concrete Association (NRMCA) certified concrete flatwork technician to supervise all finishing. Provide proof of the flatwork certification to the Engineer prior to concrete placement.

Slip-form or conventionally form the pavement unless otherwise specified. If slip-form is selected, small, irregular, or areas inaccessible to the paver may be constructed with fixed forms. These areas may be hand-finished, but must still meet all Performance Measures, Section 501.03.9. No portions of pavement shall be formed to produce a "point." Unless otherwise approved, no formed dimension shall be less than 2 feet.

At least ten (10) Calendar Days prior to paving, schedule a "Pre-paving Meeting" with representatives from the Engineer, Contractor, and other interested parties in attendance.

Submit on or before the date of the "Pre-paving Meeting," a "Means and Methods" plan. The plan shall include, but not be limited to, the Contractor's proposed:

A. Method of concrete placement and concrete delivery schedule

B. Proposed width of paving pulls

C. Installation methods for all embedded hardware

D. Typical locations of longitudinal sawed and construction joints

E. Method of transverse construction joint installation

F. Joint locations if different than shown on the plans

G. Procedure, including the finishing screed, for forming and constructing small or irregular shaped portions of pavement

H. Safety edge construction method

I. Method of installing and securing load transfer devices [Contractor to also provide a template for use by the Engineer]

J. Procedure for final texturing the pavement surface

K. Location of the concrete delivery trucks in relation to the paving area and the proposed haul route from the concrete plant

L. Hand finishing procedures and tools, including a misting or fogging device

M. Contingency plan and protective covering for rain events

N. Proposed subcontractors

O. Proposed Thermal Protection Plan for extreme hot and cold concrete placement

501.03.1 Mix Design. Prepare and submit for approval by the Engineer, prior to pre-paving meeting, a mix design as specified in Section 1022 Concrete Production; Class B/SF for slip form paving and Class B for fixed form paving.

501.03.2 Slip-Form Paving.

501.03.2.1 Equipment – Furnish and maintain all Equipment and tools for concrete batching, placement, finishing, curing, and texturing operations.

A. Batch Plant and Central Plant Equipment – Section 1022.06.2

B. Place concrete with a track operated, self-propelled, slip-form paver that can independently, or in conjunction with an advance concrete spreader:

1. Strike-off
2. Screed
3. Adjust to produce the specified cross slope and pavement width
4. Place a minimum width pavement of 24 feet in one pull
5. Operate using electronic grade controls for both horizontal and vertical alignment
6. Provide a vertical pavement edge with slump off not exceeding 1/4 inch, exclusive of edge rounding, when checked under a 10 foot straightedge
7. Vibrate and consolidate the concrete for the full width being placed. Vibrators are to be attached to the paving Equipment or mounted on a separate carriage. Vibrators shall not contact load transfer devices, embedded hardware, or forms. The Contractor is responsible for the number and frequency setting of the vibrators to achieve uniform consolidation of the concrete throughout the entire slab thickness and width. Vibration must automatically stop when forward movement of the unit is interrupted.
8. Provide a smooth, uniform concrete surface finish requiring minimal or no floating or hand finishing
9. A paver equipped with a Dowel Bar Inserter (DBI) may be utilized if approved in advance by the Engineer.

C. Concrete Saws – Provide mechanical saws capable of producing the specified joint details. The Contractor shall determine the number of saws needed based on weather, temperature, and amount of pavement

placed. Backup Equipment and lighting (if necessary) must be on site prior to beginning concrete placement.

D. Work Bridge(s) – Provide platforms spanning the full width of the paving pull so that workers can perform necessary finishing, texturing, and/or curing. The work bridge(s) shall not come in direct contact with the pavement surface.

E. Texturing – Provide independently powered, self-propelled texturing Equipment capable of adjusting the depth of tine penetration to produce the specified pavement surface texture. For formed pavement, the texturing Equipment shall ride on the forms or rails.

F. Curing – Provide mechanically powered Equipment to place curing compound at the specified rate to the pavement surface and all exposed edges. Use a fully atomized mechanical sprayer equipped with a tank agitator and wind guard.

G. Diamond Grinding – Provide self-propelled machines equipped with gang mounted diamond blades having a minimum cutting head width of 3 feet, capable of producing a "corduroy type" pavement surface texture consisting of parallel grooves between 3/32 inch and 5/32 inch wide and 1/16 inch deep. Fifty (50) to sixty (60) diamond blades per foot of cutting head are required.

501.03.2.2. Construction Methods.

A. Place and grade base course to the tolerance specified under the applicable Specification. No hardware may be placed on the grade until the Engineer has given approval.

B. Furnish and install load transfer devices. Clearly mark, on both sides of the pavement, the center of each assembly using paint, stakes, or other agreed upon method so that the transverse sawed joints can be properly located. Construct load transfer assemblies in accordance with the Contract Documents. Apply a graphite coating to each dowel just prior to concrete placement if they are AASHTO M254, Type B (fusion bonded epoxy). No additional coating is required, if the approved dowels are AASHTO M254, Type A. Locate dowels at a pavement depth of T/2, (T = pavement thickness). Securely stake or otherwise fasten, in accordance with the Standard Construction Details, the load transfer device to the subgrade to prevent movement during concrete placement. Cut the tie wires on the dowel bar basket assembly. Do not use load transfer assemblies that are damaged in any way. Verify horizontal and vertical alignment of the devices not to exceed the tolerances as defined in the Standard Construction Details. Check initial dowel placement on grade with a template or other approved tool supplied by the Contractor for use by the Engineer.

C. Furnish Hook Bolts (or W-Bolts) for use when lanes will longitudinally abut the pavement being placed, and #5 standard rebars for tie bars used under longitudinal sawed joints or for tying into concrete lanes placed under previous contracts. Install these items during or prior to concrete placement. The method of installation must be approved prior to beginning concrete placement.

D. Install lines, wires, or other devices as needed for electronic grade control.

E. Placing Concrete

1. Minimize or eliminate stopping the forward movement of the paver. Sufficient number and proper scheduling of concrete delivery trucks is required in this regard.

2. Maintain a vertical pavement edge. If necessary, use extra finishers, temporary forms, or trailing forms as part of the paver.

3. Maintain a uniform level of concrete feeding the paver screed, allowing sufficient concrete to completely fill the void under the screed for the entire width of pavement placed. A roll of concrete covering approximately half of the distributing augers is desirable. Spreaders in advance of the paver may be used to control the concrete supplied to the paver.

4. Wet the base course just prior to contact by the concrete using a hose or other spray device for uniform water application. The application rate should not cause any pooling of water on the grade.

5. As the concrete is being placed, install tie bars under longitudinal sawed joints and Hook or W-Bolts along longitudinal pavement edges requiring abutting pavement to be placed in the future.

6. Build a transverse construction joint at the end of the day's paving run in accordance with the previously approved details.

7. Prior to placing adjoining concrete paving lanes or shoulders, seal the previously sawed joint opening along the edges of the existing concrete using duct tape, caulk, or other approved material to prevent stones or grout from entering the saw cut.

8. When placing concrete in lanes adjoining previously constructed pavement, locate the full width of the paver tracks over the pavement with no overhang across the edge, in order to prevent breaking. Use rubber facing, wood, or other approved protection if the paver tracks will be in contact with the existing pavement surface. Concrete in the completed lane must have achieved a compressive strength of at least 2,000 pounds per square inch prior to placing any adjoining pavement.

9. For small, irregular sections, or areas of pavement inaccessible to the paver:

    a. Use wooden or steel forms. Depth of the forms must be at least that of the required pavement thickness. Form faces shall not deviate from a true plane by any more that 1/8 inch in 10 feet. Provide pins or other bracing to prevent movement of the forms under the weight of the concrete.

    b. Place concrete directly onto a previously approved, moistened grade. Consolidate with hand vibrators paying particular attention to not dislodge the load transfer devices or have the vibrator come in contact with the forms.

    c. Finish with a pre-approved screed. Hand float or otherwise finish any areas as necessary. Pull a damp burlap drag longitudinally along the placement area. Texture and cure in accordance with Sections 501.03.4 and 501.03.5.

    d. If forms are stripped prior to five (5) Calendar Days following concrete placement, apply curing compound or extend other curing methods immediately, after patching any "honey-combed" areas, to completely cure the exposed edge. Forms must remain in place at least 12 hours following initial concrete placement, except for areas immediately adjacent to saw cut transverse joints. Forms at these joints must be removed when required in order to complete the saw cut through the entire pavement surface. Maintain curing methods in place until the full five (5) Days has elapsed or the compressive strength of the concrete has reached 2,000 pounds per square inch.

10. Safety Edge – Construct a safety edge as specified in the Contract Documents. The safety edge is required longitudinally along the outermost pavement edge (generally a shoulder) on all mainline and ramp paving unless otherwise approved by the Engineer.

F. Finishing

1. Produce a smooth, uniform, concrete surface with the paver screed conforming to the specified pavement cross slope and width.

2. Hand finishing is limited to sealing any surface tears, supporting any non-vertical pavement edges, and to assist in the surface finish of small, irregular, or other areas inaccessible to the paver. No steel trowels will be allowed for finishing surfaces.

3. Finish all longitudinal pavement edges with a 1/4 inch rounded edging tool.

4. Do not add surface water as an aid to finishing. If absolutely necessary, an evaporation retardant may be added through the use of a misting or fogging device approved prior to beginning paving operations. Water shaken from brushes or applied through a hose is not permitted.

5. Finish the final pavement surface prior to texturing by pulling a wet burlap drag in the longitudinal direction. Keep the burlap in a moist condition throughout the paving operation in order to prevent surface tearing.

6. Texture and cure the pavement per Sections 501.03.4 and 501.03.5.

501.03.3 Fixed Form Paving.

501.03.3.1 Forms.

A. Use straight, metal forms having adequate strength to support the Equipment. Each section shall be a minimum of 10 feet in length. Use forms with a depth equal to or greater than the prescribed edge thickness of the concrete, a base width at least equal to the depth of the forms, but not required to exceed 8 inches for deeper forms, and without a horizontal joint. Use flexible or curved forms of proper radius for curves of 150 foot radius or less, except approved straight forms of 5 foot lengths may be used for curves of a radius from 75 to 150 feet. Flexible or curved forms must be approved by the Engineer. The Engineer may approve the use of wood forms in areas requiring hand finishing [see Section 501.03.2.2.e.9)]. Secure the forms in place to withstand the impact and vibration of the consolidating and finishing Equipment without visible spring or settlement. Extend flange braces outward on the base a minimum of ⅔ the height of the form. Remove forms with battered top surfaces or bent, twisted, or broken forms. Do not use repaired forms until they have been inspected and approved by the Engineer. Do not use buildup forms, except where the total area of pavement of any specified thickness on the project is less than 2,000 square yards. Do not vary the top face of the form from a true plane more than ⅛ inch in 10 feet, and do not vary the vertical face of the form by more than ¼ inch. Make provisions for locking the ends of abutting form sections together tightly, and for secure setting.

B. Supplementary Rails

1. Provide suitable metal rails capable of being securely attached to the top of the side forms to provide a track that will allow spreading, finishing, and curing Equipment to back over the end of the previous day's run.

2. Ensure metal rail length is sufficient to accommodate all Equipment that must be backed out of the way. Also, ensure the rails are of such a height that all wheels and flanges of wheels will clear the previously placed concrete by at least 1/2 inch.

C. Base Support - Provide a foundation under the forms so that the whole length of the form will be set firmly in contact with the grade.

D. Form Setting - Set forms sufficiently in advance of the point where concrete is being placed so that line and grade may be checked. Stake forms into place with a minimum of 3 pins for each 10 foot section. Place a pin at each side of every joint. Tightly lock form sections to be free from play or movement in any direction. Do not deviate the form from true line by more than ¼ inch at any point. No excessive settlement or springing of forms is permitted from the weight of the finishing machine. Clean and oil forms before the placing of concrete.

E. Grade and Alignment - Check the alignment and grade elevations of the forms immediately before placing the concrete and make any necessary corrections. When any form has been disturbed or any grade has become unstable, reset and recheck the form.

F. Removing Forms - Do not remove forms from freshly placed concrete until it has set for a minimum of 12 hours, except for auxiliary forms used temporarily in widened areas and forms against transverse saw cut joint locations. Remove forms carefully to avoid damage to the pavement.

501.03.3.2. Equipment - Furnish and maintain all Equipment and tools for concrete batching, placement, finishing, curing, and texturing operations.

A. In addition to the Equipment included in this Section, all Equipment listed under Section 501.03.2.1 is required except that Section 501.03.2.1.b is replaced with the following for fixed form paving:

B. Place concrete with a finishing machine designed for fixed form paving that can ride on previously set forms and can independently, or in conjunction with an advance concrete spreader:

1. Strike-off

2. Screed

3. Adjust to produce the specified cross slope and pavement width

4. Place a minimum width pavement of 12 feet in one pull

5. Provide a smooth, uniform concrete surface finish requiring minimal or no floating or hand finishing

C. Vibration

Vibrate and consolidate the concrete for the full placement width. Vibrators are to be attached to the paving Equipment or mounted on a separate carriage. Only operate the vibrators when the machine on which they are mounted is moving forward. Do not operate hand vibrators more than 10 seconds, or less than 5 seconds in any one location unless approved otherwise by the Engineer. Place vibrators in and withdraw from concrete vertically in a slow deliberate manner. In order to obtain concrete consolidation in the vicinity of joint assemblies, the Engineer may require that these areas be hand vibrated with an immersion spud vibrator. Vibrators shall not contact load transfer devices, embedded hardware, or forms. The Contractor is responsible for the number and frequency setting of the vibrators to achieve uniform consolidation of the concrete throughout the entire slab thickness and width.

D. Form Line Excavating Machine

Excavate form lines for all forms supporting mechanical finishing Equipment to line and grade by a machine designed for this purpose and approved by the Engineer, or an approved machine that concurrently trims the subgrade or subbase to grade.

E. If, during the operation of paving Equipment, it is necessary to operate one or both sets of wheels or tracks on previously placed concrete, adjust or alter the wheels or tracks so that the bearing on the concrete will not be closer than 3 inches from the pavement edge. When operating with one side of the machine on pavement and the other side on forms, the wheels operating on the forms may be double flanged. Use flangeless, rubber faced wheels on the pavement. When operating over the edge of concrete less than 2 months old, support the ends of the finishing machine screeds with an approved device to provide from 1/16 to 1/8 inch clearance between the screed and previously placed pavement.

501.03.3.3. Construction Methods.

A. No hardware may be placed on the grade in contact with the concrete pavement until the Engineer has given approval to do so. Place and grade the base course to the tolerance specified under the applicable Specification.

B. Furnish and install load transfer devices. Clearly mark, on both sides, the center of each assembly using paint, stakes or other agreed upon method so that the transverse sawed joints can be properly located. Unless otherwise specified in the Contract Documents, construct load transfer assemblies in accordance with the Standard Construction Details. Apply a graphite coating to each dowel just prior to concrete placement if they are AASHTO M254, Type B (fusion bonded epoxy). No additional coating is required, if the approved dowels are AASHTO M254, Type A. Locate dowels at a pavement depth of T/2, (T = pavement thickness). Securely stake or otherwise fasten, in accordance with the Standard Construction Details, the load transfer device to the subgrade to prevent movement during concrete placement. Do not use load transfer assemblies that are damaged in any way. Verify horizontal and vertical alignment of the devices not to exceed the tolerances as defined in the Standard Construction Details. Check initial dowel placement on grade with a template or other approved tool supplied by the Contractor for use by the Engineer.

C. Furnish Hook Bolts (or W-Bolts) for use when lanes will longitudinally abut the pavement being placed, and #5 standard rebars for tie bars used under longitudinal sawed joints or for tying into concrete lanes placed under previous contracts. Install these items prior to or during concrete placement. The method of installation must be approved prior to beginning concrete placement.

D. Placing Concrete

1. Minimize or eliminate stopping the forward movement of the paver. Sufficient number and proper scheduling of concrete delivery trucks is required in this regard.

2. Maintain a uniform level of concrete feeding the paver screed, allowing sufficient concrete to completely fill the void under the screed for the entire width of pavement placed. Spreaders in advance of the paver may be used to control the concrete supplied to the paver.

3. Wet the base course just prior to contact by the concrete using a hose or other spray device for uniform water application. The application rate should not cause any pooling of water on the grade.

4. As the concrete is being placed, install tie bars under longitudinal sawed joints and Hook or W-Bolts along longitudinal pavement edges requiring abutting pavement to be placed in the future.

5. Build a transverse construction joint at the end of the day's paving run in accordance with the previously approved details.

6. Prior to placing adjoining concrete paving lanes or shoulders, seal the previously sawed joint opening along the edges of the existing concrete using duct tape, caulk, or other approved Material to prevent stones or grout from entering the saw cut.

7. When placing concrete in lanes adjoining previously constructed pavement, the paver tracks must be fully in contact with the completed pavement surface to prevent breaking of the edge. Use rubber facing, wood, or other approved protection if the paver tracks will be in contact with the existing pavement surface. Concrete in the completed lane must have achieved a compressive strength of at least 2,000 pounds per square inch prior to placing any adjoining pavement.

8. For small, irregular sections, or areas of pavement inaccessible to the paver:

   a. Use wooden or steel forms. Depth of the forms must be at least that of the required pavement thickness. Form faces shall not deviate from a true plane by more than 1/8 inch in 10 feet. Provide pins or other bracing to prevent movement of the forms under the weight of the concrete.

   b. Place concrete directly onto a previously approved, moistened grade. Consolidate with hand vibrators, paying particular attention not to dislodge the load transfer devices or come in contact with the forms.

   c. Finish with a pre-approved screed. Hand float or otherwise finish any areas as necessary. Pull a damp burlap drag longitudinally along the placement area. Texture and cure in accordance with Sections 501.03.4 and 501.03.5.

   d. When forms are stripped following concrete placement prior to five (5) Calendar Days following placement, apply curing compound or extend other curing methods immediately after patching any "honey-combed" areas to completely cure the exposed edge. Forms must remain in place at least 12 hours following initial concrete placement, except for areas immediately adjacent to saw cut transverse joints. Forms at these joints must be removed when required in order to complete the saw cut through the entire pavement surface. Maintain the curing in place until a full five (5) Days has elapsed or the compressive strength of the concrete has reached 2,000 pounds per square inch.

9. Safety Edge – Construct a safety edge as specified in the Contract Documents. The safety edge is required longitudinally along the outermost pavement edge (generally a shoulder) on all mainline and ramp paving unless otherwise approved by the Safety Program Manager or Designee.

E. Finishing

1. The paver screed shall produce a smooth, uniform concrete surface conforming to the specified pavement cross slope and width.

2. Limit hand finishing to sealing any surface tears, supporting any non-vertical pavement edges, and to assist in the surface finish of small, irregular, or other areas inaccessible to the paver. No steel trowels will be allowed for finishing surfaces.

3. Finish all longitudinal pavement edges with a 1/4 inch, rounded edging tool.

4. Do not add surface water as an aid to finishing. If absolutely necessary, add an evaporation retardant through the use of a misting or fogging device approved prior to beginning paving operations. Water shaken from brushes or applied through a hose is not permitted.

5. Create a final pavement surface prior to texturing by pulling a wet burlap drag in the longitudinal direction. Keep the burlap in a moist condition throughout the paving operation in order to prevent surface tearing.

6. Texture and cure the pavement per Sections 501.03.4 and 501.03.5.

501.03.4 Texturing.

A. Texture the finished pavement for the entire placement width with an approved tining device. Flat steel wire tines are required and shall be 3/32 inches wide and 5 to 6 inches in length unless otherwise approved, having a 3/4 inch spacing between the tines. The tines shall form rectangular shaped grooves 1/16 inch to 3/16 inches in depth. Do not texture portions of the pavement that will receive permanent pavement markings. In these areas, maintain a 10 inch wide flat surface to accommodate the striping and/or raised pavement markers. The burlap drag finish is acceptable for these areas

B. The Contractor may elect to diamond grind all surfaces of concrete pavement to create a final texture. If so, do not perform the grinding until the concrete has obtained a compressive strength of at least 3,500 pounds per square inch.

C. Pull the tining in the longitudinal direction, parallel to the centerline of the pavement, in one pass without dragging or tearing the mortar.

D. The Contractor is responsible to determine the proper time to install the tining. The tining should not pull excessive mortar or aggregate from the pavement (too early) or fail to penetrate the surface by the minimum 1/16 inch (too late).

E. Make available hand tining devices at least 4 feet in width, equipped with tines identical to those specified above, for use in areas inaccessible to the mechanical device.

F. Immediately follow the tining operation with approved curing.

501.03.5 Curing – Use one of the methods listed below.

A. White Membrane Curing Compound

1. Spray the curing Material on the pavement surface and all exposed edges immediately following the texturing operation.

2. Continuously agitate the curing Material during application to keep it thoroughly mixed.

3. Uniformly apply 2 applications of spray to the entire surface at a rate covering no more than 200 square feet (22.2 square yards) per gallon per each of the 2 applications. Apply the first coat immediately following the tining operation and the second coat no more than 30 minutes after the first.

4. If necessary, use hand sprayers for pavement edges or small and irregular areas inaccessible to the larger mechanical applicator. The rate of application remains no more than 200 square feet per gallon per each of the 2 applications.

5. No Equipment or traffic (other than joint saws and foot traffic) is permitted on the pavement until the compressive strength has reached at least 2,000 pounds per square inch.

B. Polyethylene Film

1. Extend the polyethylene beyond the slab edges by at least twice the pavement thickness and add weight to secure the material against wind and weather.

2. Maintain the polyethylene in place for at least 5 Calendar Days or until the concrete compressive strength has reached at least 2,000 pounds per square inch. At sawed joint locations, remove as little polyethylene as possible just prior to the sawing operation. Re-cover the area over the sawed joint immediately upon completion of the sawing operation and maintain for the remainder of the curing period.

501.03.6 Quality Control Plan.

Develop and submit a Quality Control Plan in accordance with Section 610.03.A, except as modified herein.

501.03.6.1 Temperature Limitations.

A. Cold Weather –

1. Do not place concrete when the ambient air temperature in the shade, and away from artificial heat, is less than 35 degrees Fahrenheit. Resume placement when the ambient air temperature is 35 degrees Fahrenheit and rising.
2. Do not place concrete on frozen grade.
3. Maintain temperatures of not less than 50 degrees Fahrenheit surrounding the concrete pavement for a curing period of five (5) Calendar Days following placement of the concrete. Provide all necessary monitoring devices (High-Low thermometers or other tools) and a plan for monitoring the temperature during the five (5) Day period ensuring placed concrete is not damaged by the temperatures. Use of insulating blankets, straw, polyethylene, or other protection subject to the approval of the Engineer, must be addressed in the plan.

B. Hot Weather

1. If plastic concrete temperatures reach 80 degrees Fahrenheit, give additional attention to dampening the subgrade immediately in advance of the concrete placement. Perform finishing, texturing, and curing operations as soon as possible. Should the pavement surface dry out to the extent that it cannot be sealed without the application of surface water, paving shall be suspended.
2. No concrete may be placed when the temperature of the plastic concrete exceeds 90 degrees Fahrenheit at the production facility.
3. Regardless of the protection methods selected, the Contractor is responsible to protect the concrete from freezing or other thermal damage. Any removal, replacement, and/or repairs resulting from thermal damage will be made at the Contractor's expense.

501.03.7 Joints.

A. Transverse Sawed Joints

1. Saw the joints at the specified spacing to a depth of T/3 + 1/4 inch (T = Pavement Thickness) and a width of 1/8 inch.
2. Begin joint sawing as soon as the concrete can support the saw and operator with no damage to the pavement surface.
3. Time the sawing so that the concrete does not ravel behind the blade and so that random cracking does not occur.
4. Determine the timing of the saw cutting based on weather, temperature, and his/her judgment. Center the saw cuts over the load transfer dowels. Following transverse saw cutting, provide crack-free pavement except for the cracks under the designed saw cut joints.

B. Longitudinal Sawed Joints

1. Following the transverse joint saw cutting, perform longitudinal saw cutting on pavement placed in multi-lane (or lane and shoulder) pulls. Saw the joints to a depth of T/3 + 1/4 inch and to a width of 1/8 inch.
2. Determine the timing of the saw cutting based on weather, temperature, and his/her judgment. Center the saw cuts over the tie-bars. Following longitudinal saw cutting, provide crack-free pavement except for the cracks under the designed saw cut joints.

C. Transverse Construction Joints

1. Construct this joint at the end of a day's paving run.

2. Prior to beginning paving operations, provide a formed bulkhead for use in an emergency necessitating a non-planned paving stoppage exceeding 30 minutes.

3. Submit for approval the proposed method of building the transverse construction joint. The resulting joint must create a vertical face perpendicular to the pavement conforming to the designed cross slope having load transfer dowels spaced the same as the load transfer devices. Finish the top edge with a 1/4 inch rounded edging tool. If the proposed construction method involves drilling and grouting load transfer dowels, they must be of the same Material and dimensions as those provided as part of the load transfer devices. Drilling and grouting procedures and related Materials must accompany the submission, if applicable. Provide a grout retainer ring if dowels will be installed by drilling and grouting.

4. When placing concrete pavement abutting the transverse construction joint, use a 1/4 inch rounded edging tool to finish the top edge of the concrete in contact with the previously constructed joint. If tying into a non-rounded edge of existing pavement, saw cut a 1/4 inch bevel on the existing pavement edge prior to placing the new adjoining concrete pavement.

D. Longitudinal Construction Joints

1. Construct these joints directly over Hook Bolts or W-Bolts installed in a previously placed run of pavement. If tying into concrete placed under a previous contract, drill and grout tie-bars (#5 rebars) into the existing concrete pavement if so noted in the Contract Documents.

2. Form the joint by finishing the concrete abutting the existing concrete with a 1/4 inch rounded edging tool. If tying into a non-rounded edge of existing pavement, saw cut a 1/4 inch bevel on the existing pavement edge prior to placing the new adjoining concrete pavement.

E. Unless detailed otherwise in the Contract Documents, no joint sealant Material is required in any of the joints covered in this Section.

501.03.8 Opening the Road to Traffic.

When the compressive concrete strength has reached at least 3,500 pounds per square inch.

501.03.9 Performance Measures.

Acceptance and final payment for this Item will be based on the Contractor's ability to acceptably construct a concrete pavement meeting the following criteria:

A. Alignment and cross-slope

1. Maintain a pavement edge within 0.15 feet of the specified horizontal alignment. Pavement width provided must be no less than that specified.

2. Provide the cross-slope at the specified percent plus or minus 0.5%.

B. Consolidation as verified by visual observation of pavement edges, pavement cores, and/or other non-destructive testing as determined by the Engineer.

C. Thickness as verified by cores. Payment to be adjusted in accordance with Section 501.05.

D. Ride quality as specified in Section 501.05 with payment adjustments as specified therein.

E. Pavement free of random cracks – Any uncontrolled random cracks must be repaired or removed and replaced prior to Final Acceptance and payment. Submit repair or replacement procedure and details for approval by the Engineer.

F. Provide a vertical pavement edge having no more than 1/4 inch edge slump, exclusive of rounding of the finishing tool, when measured under a 10 foot straight edge.

G. Provide load transfer dowels located as specified in Section 501.03.2.2.b. Verify specification compliance of load transfer dowel bar locations and alignment using non-destructive testing devices.

H. Provide concrete meeting the required compressive strength requirements subject to payment Adjustment as outlined in Section 501.05.

501.03.10 Tolerance in Pavement Thickness.

For the purpose of establishing an adjusted Unit Price for pavement lanes, the following is considered:

A. The Engineer will divide the PCC Pavement for the entire Contract into 1,000 square yard lots, determine the random core locations, drill the cores, determine pavement thickness according to AASHTO T 148, and patch the resulting holes in the PCC Pavement.

B. Uneven lots less than 1,000 square yards may occur due to the pavement geometry. If this is the case, these irregular lots will be considered a complete lot when evaluating the pavement thickness, regardless of their actual size.

C. If a random core measurement is deficient by more than 0.20 inch when compared to the Plan pavement thickness, 2 additional randomly selected cores will be taken within the same lot. Cores measuring 0.20 inch or more in excess of the Plan pavement thickness will be considered to measure exactly 0.20 inch greater than the planned thickness when computing the average of the 3 cores. The average thickness of the 3 cores will be considered the pavement thickness for the lot being evaluated. This lot thickness will be used to determine payment for the entire lot in accordance with Table 501.05.1.

Remove and replace the entire lot represented by the short cores when any average lot thickness is deficient by more than 1 inch when compared to the Plan pavement thickness. The Engineer will provide the limits of the lot in question.

501.03.11 Pavement Smoothness Testing.

501.03.11.1 General Description. Test finished surfaces of concrete pavements, Bridge decks, approach slabs, and transition slabs in accordance with the Contract Documents using an Inertial Profiler unless otherwise stated.

501.03.11.2 Straight Edge Surface Testing. In the absence of the requirement for Inertial Profiler smoothness testing, surface testing will be performed with a rolling straight edge or a conventional straight edge furnished by the Contractor. Finished concrete pavement and/or Bridge surfaces will be tested by the Contractor and witnessed by the Engineer for trueness in each wheel lane at the completion of the required curing or protection period. Test the surface with a rolling 10 foot straight edge, or a 10 foot straight edge 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 foot rolling straight edge, or measured from the base of the straight edge to the surface of the pavement, shall not exceed 0.25 inch. An approved 10 foot long straight edge shall be available at all times during concrete paving operations.

501.03.11.3 Surface Corrections. Use diamond grinding to remove deviations exceeding 0.25 inch in 10 feet and/or to improve ride quality. Submit, for review by the Engineer, similar types of work performed with the proposed Equipment, including references if requested.

501.04 Method of Measurement.

The quantity will be measured as the actual square yards placed and accepted. Pavement width measurement not to exceed that shown on the Plans unless otherwise approved. Longitudinal dimension measured along the centerline of pavement.

Areas requiring repairs due to random cracking or failure to meet other performance measures will not be measured for payment until the repairs have been successfully completed. In these cases, the actual repair area (dimensions of the patch or other repair) will be the quantity withheld from payment.

501.05 Basis of Payment.

Payment includes furnishing all Equipment, Materials, and incidentals; placing, finishing, texturing, and curing concrete pavement meeting the performance measures outlined in Section 501.03.9. Incidental to the Item are the following, but not limited to:

A. Repairs to random crack areas.

B. Repairs required to meet performance measures.

C. Furnishing a "Thermal Plan" and any accompanying testing Equipment.

D. Furnishing inertial profiling system, operator, and straight edge for smoothness testing; providing specified results for same.

E. Performing diamond grinding for Specification compliance and/or ride quality improvement.

F. Sawing, drilling, grouting, and constructing all pavement joints.

G. Sealing sawed joints along the completed pavement edge prior to placing adjoining pavement.

H. Constructing safety edge.

I. Cold weather curing Materials if necessary.

J. Lighting in order to perform Work, if needed.

K. Template or other approved device for checking dowel bar assembly installation prior to concrete placement. This to be supplied to the Engineer for use during paving operations and returned to the Contractor at the conclusion of paving.

L. Maintenance of traffic, if required for smoothness testing.

M. Polyethylene covering and transverse bulkhead for protecting concrete during a rain event or other emergency.

N. Verifying load transfer dowel bar location and alignment using non-destructive testing devices.

O. Any other incidental Items mentioned in the body of this Specification.

501.05.1 Pavement Thickness Adjustments.

A. For thickness deficiencies, the Department will adjust the Contract Unit Price according to the schedule provided in Table 501.05-A.

Table 501.05-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 inches	100
0.21 to 0.30 inches	80
0.31 to 0.40 inches	72
0.41 to 0.50 inches	68
0.51 to 0.75 inches	57
0.76 to 1.00 inches	50
Greater than 1.00 inch	Remove and Replace

B. No additional payment over the Contract Unit Price will be made for any pavement with an average thickness in excess of that shown on the Plans. The maximum pavement thickness value used in this chart for a 1,000 square yard lot will be the Plan pavement thickness.

501.05.2 Pavement Smoothness Acceptance and Payment.

Apply any incentive/disincentive pay Adjustments as established by this Specification and in accordance with the Contract Documents.

501.05.3 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 Categories A and B of Section 610.03.M of the Standard Specifications. Make prorated payment in accordance with Section 610.03.M. Concrete having compressive strength of 500 pounds per square inch or more below the designed f'_c of the pavement shall be removed and replaced at no cost to the Department.

ITEM	DESCRIPTION	UNIT
501001	PORTLAND CEMENT CONCRETE PAVEMENT, 8”	SY
501002	PORTLAND CEMENT CONCRETE PAVEMENT, 9”	SY
501004	PORTLAND CEMENT CONCRETE PAVEMENT, 10”	SY
501005	PORTLAND CEMENT CONCRETE PAVEMENT, 11”	SY
501006	PORTLAND CEMENT CONCRETE PAVEMENT, 12”	SY
501012	PORTLAND CEMENT CONCRETE PAVEMENT, 14”	SY

SECTION 503 – PATCHING PORTLAND CEMENT CONCRETE PAVEMENT

503.01 Description. Remove and dispose of existing Portland cement concrete pavement and replace it with new Portland cement concrete pavement. The Engineer will designate the boundaries of each repair. This Work is not intended for repairing newly constructed Portland cement concrete pavement or for repairing continuously reinforced concrete pavement. Complete full depth patching under this Item after any planned partial depth patching and before any diamond grinding or overlay.

503.02 Materials. Provide Materials as specified in the following:

Portland Cement Concrete, Class A	Section 1022
Load Transfer Devices	Section 1037
Epoxy Grout	Section 1047
Joint Sealants	Section 1042
Curing Materials	Section 1022

503.03 Construction. Provide an American Concrete Institute (ACI) or National Ready Mix Concrete Association (NRMCA) certified concrete flatwork technician to supervise all finishing. Provide proof of the flatwork certification to the Engineer prior to concrete placement.

503.03.1 Patching Limits. Pavement to be patched will be indicated in the Contract Documents, or identified by the Engineer. Patching limits will be painted on the existing pavement by the Engineer.

Patches can be either Type 'A' or Type 'B'. A Type 'A' patch is 15 feet or less in length. A Type 'B' patch is greater than 15 feet and less than 100 feet in length and contains load transfer assemblies spaced at a maximum of 15 feet.

Construct pavement replacement greater than 100 feet in length under Section 501 - Portland Cement Concrete Pavement.

Patch limits in the direction of traffic shall either match or be offset by at least 2 feet from the existing concrete pavement joints, any cracks, or patch ends in the immediate adjacent lanes.

Patch lengths shall be at least 6 feet and no more than 15 feet without a load-transfer device. The patch shall be the full width of the existing slab or as noted on the Contract Documents. The patch depth shall be no less than the existing slab.

503.03.2 Saw Cutting. Refer to and comply with all requirements listed in Section 762 of the Standard Specifications. Construct all perimeter cuts plumb and parallel or normal to the centerline of the roadway. Cutting existing bituminous overlays up to 8 inches thick over the concrete is incidental to the concrete saw cutting Item, unless otherwise noted in the Contract Documents. Minimize and seal any over-cut into the remaining slabs as directed by the Engineer. Cut any existing tie-steel across the patch perimeter (cost incidental to the concrete saw cut). The Contractor may make additional cuts (such as diagonal and slanted cuts) to facilitate the removal of the concrete within the patch boundaries. The additional cuts to facilitate removal are incidental to the saw cutting Item and will not be measured or paid. Cutting shall not precede the removal operations by more than two (2) Days. Remove and properly dispose of concrete slurry remaining after saw cutting in accordance with Section 106.08 of the Standard Specifications. Clean all travel lanes to the satisfaction of the Engineer before opening to traffic following the saw cutting operation.

503.03.3 Patch Removal. Remove the patch and any remaining bituminous overlay in the patch area by the lift-out technique without damaging the remaining concrete slabs or disturbing the base and subgrade. If the bituminous overlay is to be replaced, payment will be made for the overlay using the applicable bituminous concrete Item. Drill holes into the patch to insert lifting hooks, pins, or chains. Improper actions (such as dropping the removed slab on adjacent concrete pavement, damaging the pavement edge due to the Contractor's methods, or other actions deemed damaging by the Engineer) leading to slab damage shall be repaired by the Contractor, by an approved method, at no cost to the Department.

When the lift-out technique is not feasible, break and remove the concrete in the patch area using an approved mechanical pavement breaker or jackhammer. Execute the removal of the existing concrete and bituminous overlay (if applicable) with minimal disturbance to the remaining concrete or foundation. Repair any damage beyond the limits of the patch, caused by the improper actions of the Contractor, to the satisfaction of the Engineer, at no cost to the Department.

Where the patch is next to the shoulder and removal of the concrete results in a clean, uniform shoulder edge, the Engineer may allow the Contractor to use the shoulder edge as the form for the new concrete. Repair in kind any portion of the shoulder pavement structure removed or disturbed by the patching operation (if the shoulder is not designated for replacement). Costs of the repair are incidental to the patching Item(s). Saw cutting the joint between the concrete pavement and shoulder may assist in maintaining a clean, uniform shoulder edge. If the adjacent shoulder is concrete, the saw cut will be measured and paid for. If the adjacent shoulder is bituminous concrete, no measurement or payment will be made for the saw cut. If the bituminous shoulder is damaged during concrete removal, then place a side form to provide a vertical edge for the concrete patch.

503.03.4 Patch Preparation. After removal of the concrete, if the base material is unsuitable or washed out, remove any base or subgrade material that is unstable to a maximum depth of 6 inches as directed by the Engineer. Do not place any new base material. Fill the excavated area with concrete when the patch is placed. Clean out the repair area with hand tools and protect the patch subgrade from water intrusion when precipitation is forecasted. Excessive moisture remaining after excavation may require the construction of a pipe underdrain system as directed by the Engineer and as shown in the Contract Documents.

In areas of composite pavements (bituminous concrete over P.C.C. pavement) and if the Contractor elects to pour the concrete patch flush with existing bituminous concrete pavement to eliminate grade differential, the additional depth, not to exceed 6 inches, shall be placed as directed by the Engineer.

Give particular attention to existing longitudinal joint areas where loose concrete may have cracked away from the plumb line during patch removal. Clean all vertical faces of loose and deleterious material prior to the placement of concrete.

Just prior to concrete patch placement, spray a light coating of wax-based curing compound bond breaker on the longitudinal and transverse vertical faces of existing concrete pavement adjacent to the patch.

503.03.5 Load Transfer Devices and Dowels Installation. Provide dowel support baskets conforming to the requirements of the Contract Documents. For Type B patches, fabricate the load transfer assemblies from dowels meeting the requirements of Section 1037. If not specified in the Contract Documents, use epoxy grout conforming to AASHTO M235 to anchor dowels. All sacrificial bars in basket must be cut after placement.

A. *Equipment*. Use drills capable of producing holes of proper size, depth, and angle with no damage to the surrounding concrete. Use a drill support system to maintain proper hole alignment. Gang drills are required for use on Contracts requiring multiple patches. If unacceptable spalling, cracking, or other damage to the remaining concrete pavement is caused by the drilling operation, then the Contractor must saw out the damaged portion of pavement, full lane width, and redrill the holes with proper Equipment. No measurement or payment will be made for removing and patching damaged areas.

B. *Placement*. Place dowels to provide load transfer at both transverse ends of the patch as shown in the Contract Documents. Allow 12 inches (typical), and no less than 6 inches from the longitudinal slab edge, to the center of the first and last dowel holes along the transverse ends of the patch.

   For slabs less than 10 inches thick, use 18 inch long dowels with a diameter of 1-1/4 inches. For slabs greater than or equal to 10 inches thick, use 20 inch long dowels with a diameter of 1-1/2 inches.

   Drill the dowel holes parallel to the profile and centerline of the pavement to an embedment depth of half the dowel bar length. Drill holes to a diameter 1/16 inch greater than the dowel when epoxy grout is used. Use compressed air to clean the holes prior to grout or epoxy placement.

   Place the anchoring grout or epoxy using a nozzle or wand that will deposit the Material to the back of the hole. Do not push or pour the anchoring Material into the holes. Install the dowel into the grout using a twisting motion of about one revolution to completely coat the dowel surface. Install a plastic grout

retention disk around each dowel to prevent grout loss and to help center the dowel in the hole. A small amount of grout should be visible around the ring when the hole is properly filled. Support the dowels in proper alignment until the grout has sufficiently set. Align the dowel bars not to exceed the tolerances as indicated in the Contract Documents. Fill any unused hole with epoxy grout. Any damage caused by the Contractor's technique shall be repaired at no added cost to the Department.

503.03.6 Placing Concrete. Dampen the subgrade just prior to concrete placement. Deposit patching concrete directly on the moist subgrade and uniformly distribute and spread it over the entire patch area. Cast each patch area in one continuous operation. Consolidate the concrete using a standard spud-type vibrator. The vibrator must be capable of visibly affecting the concrete from a distance of 1' from the vibrator head. Insert the vibrator vertically into the concrete without dragging it through the mix.

A. Temperature Restrictions. Unless specifically approved otherwise by the Engineer, place patching concrete only when the air temperature measured in the shade is 35 degrees Fahrenheit and rising. Concrete temperatures shall meet the requirements of Section 1022.06.

503.03.7 Concrete Strength Requirements. Place Class A concrete having a minimum compressive strength of 2,000 pounds per square inch or full design strength as noted in the Contract Documents within 6 hours of concrete placement. Provide Sure-Cure Mold test cylinders and all associated Equipment for use by the Engineer. The concrete will be sampled and tested by the Engineer. The Engineer may also use the concrete maturity meter in accordance with AASHTO T 325 to determine compressive strength.

The Contractor, in order to accomplish the designed compressive strength in 6 hours, shall establish the actual combination of weights and proportion of admixtures as required by the field conditions, ambient temperature, humidity, and wind conditions. If the Contractor, due to unfavorable weather conditions, is unable to accomplish the desired strength in 6 hours, they may reschedule the patching Work subject to approval by the Engineer. Failure to meet the compressive strength may cause the concrete to be considered defective based upon its structural adequacy.

Remove and replace concrete determined to be structurally inadequate by the Engineer, at no additional cost to the Department. Concrete determined to be structurally adequate by the Engineer, but not meeting 2,000 pounds per square inch in 6 hours, may remain in place at a prorated payment as specified below in Section 503.05.1. If the Contractor does not wish to accept the prorated payment, the concrete shall be removed and replaced at no cost to the Department.

503.03.8 Finishing Concrete. Except when a bituminous surface patch over the concrete is required or when an overlay will be placed, strike off the concrete surface flush with the existing pavement. For patches up to 10 feet long, place the screed parallel to the centerline of the roadway. For longer patches, the screed may be placed perpendicular to the centerline of the roadway.

When the patch surface will be overlaid with bituminous concrete, use a broom or tined finish on the concrete patch, with the texture applied in a direction perpendicular to the traffic flow. Match the adjacent pavement surface cross slope and profile. If the profile in the finished patch area contains excessive surface deviations, the patch is unacceptable. Excessive deviations are surface deviations greater than 1/4 inch from a reference line between points not greater than 10 feet apart along the direction of traffic.

When the concrete patch will be the final roadway surface, match the texture of the adjacent pavement. The patch surface cross section shall also match the preceding and following pavement surfaces. No steel trowels will be allowed for finishing surfaces. The Engineer may test for excessive surface deviations with a straightedge, a profilometer, or other surface measuring device. When tested with a straightedge, excessive deviations are surface deviations greater than 1/4 inch from a reference line between points not greater than 10 feet apart along the direction of traffic.

Repair any damaged concrete or bituminous shoulder before the patch area is subjected to traffic loading.

503.03.9 Curing and Protecting. Cure and protect the finished patch with either a liquid membrane curing compound and polyethylene sheeting or wet burlap and polyethylene sheeting, and insulating blankets as required to ensure Specification compliance.

A. Liquid membrane curing compound / polyethylene sheeting. Apply uniformly upon completion of the patch texturing at a rate of 150 square feet per gallon and then cover with polyethylene sheeting. Securely anchor the polyethylene to protect against wind, rain, or adjoining traffic.

B. Burlap / polyethylene sheeting. Cover the patch with a layer of wet burlap immediately; then cover the wet burlap with a polyethylene sheet. Securely anchor the polyethylene to protect against wind, rain, or adjoining traffic.

After the curing compound/polyethylene sheeting or burlap/polyethylene sheeting is applied, cover the patch with an approved insulating blanket. Blankets shall remain in place until the concrete has achieved the design strength (or 2,000 pounds per square inch if not noted otherwise). Secure edges and seams in the insulation to prevent dislodging due to wind, rain, or adjoining traffic. Required thickness of each insulating blanket is at least 2 inches.

503.03.10 Joints. Form or saw transverse and longitudinal joints as shown in the Contract Documents. Saw transverse joints within the patch area (Type B patches only) at the proper time to assure proper crack control at the transverse joint. Clean and seal the joints around the entire patch perimeter and all transverse joints in larger patches with hot-poured sealant Material within five (5) Days after concrete placement if no overlay is planned. Refer to and comply with all Section 504 requirements.

If the pavement is to be overlaid, then the transverse joints at the ends of the patch need only be tooled. No sealant reservoir is required in this case. Widen and seal the sawed transverse joints for crack control within Type B patches for both finished surface and overlay conditions.

If bituminous pavement is required over the patch area only (and a complete pavement overlay will not be placed), a 1/4 inch wide x 1/2 inch reservoir shall be formed in the bituminous Material around the patch perimeter when the Material is placed. Fill the resulting reservoir with hot-poured joint sealant in accordance with Section 504.

503.04 Method of Measurement.

Patching PCC Pavement, 6 foot to15 foot, Type A and Patching PCC Pavement Greater than 15 foot to 100 foot, Type B – Square Yard, of concrete patch placed and accepted. The width of measurement will be the full 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 the pavement, along the center of the patch. Additional patch areas made necessary due to improper concrete removal or saw cutting will not be measured for payment.

Undercut Excavation, Patching – Cubic Yard for material removed below the bottom of the original concrete pavement being patched; refer to Section 202 Excavation and Embankment.

*Patching Concrete – S*quare Yard-Inch, for concrete placed in undercut areas below the bottom of the original pavement requiring the patch, and/or additional thickness above in order to eliminate grade differential in finished pavements.

Saw cutting Concrete, Full Depth – Refer to Section 762 for saw cutting.

Dowel Bars – Each, for the actual number of dowel bars installed and accepted at the ends of each patch. Paid for under Item 503006. Dowel bars and support assemblies (load transfer assemblies) installed at internal crack control joints in Type B Patches will not be measured but are considered incidental to the Contract Unit Price per square yard for Item 503002 - Patching P.C.C. Pavement, greater than 15 foot to 100 foot, Type B.

Crack and Joint Sealing Less than 3/4 Inch Wide – Refer to Section 504 Crack and Joint Sealing.

503.05 Basis of Payment.

Type A Patches (Item 503001) - Square Yard payment will constitute full compensation for furnishing, hauling, and placing all Materials, including patching concrete, Sure-Cure test molds, and curing Materials; for removing, and disposing of existing concrete and any bituminous overlay remaining on the patch area at the time of removal; for preparing the foundation; for tooling, finishing, curing, texturing, sealing of over-cuts in non-overlay areas, and protecting the new concrete; for disposing of excess material; and for all labor, Equipment, tools, and incidentals required to complete the Work.

Type B Patches (Item 503002) – Square Yard payment includes everything listed under Basis of Payment for Type A patches, plus furnishing and installing load transfer assemblies at all transverse joint locations except for the

perimeter joints at either end of the patch; for transverse saw cutting, furnishing and installing transverse joint backer rod.

Undercut Excavation, Patching (Item 202004) – Paid separately under and in accordance with Section 202.

Patching Concrete (Item 503004) – Square Yard-Inch payment includes furnishing and placing concrete to depths not to exceed 6 inches resulting from the Undercut Excavation, Patching item, and/or in order to eliminate grade differential of finished pavements. Place the concrete as part of the concrete patch, Type A or Type B, in one operation.

Saw Cutting Concrete, Full Depth (Item 762002) – Paid separately under and in accordance with Section 762.

Dowel Bars (Item 503006) – Payment for each dowel includes drilling the holes, furnishing, and installing the dowel bar, anchoring grout, grout retainer disks, and temporary dowel supports to maintain alignment.

Crack and Joint Sealing Less Than ¾" Wide (Item 504001) – Paid separately under and in accordance with Section 504.

503.05.1 Price Adjustment for Low Strength Concrete. Calculate prorated payment for concrete, as referenced in Section 503.03.8, as shown in the following equation:

$$Prorated\ Payment = \frac{Actual\ 6\ hour\ Compressive\ Strength}{Specified\ 6\ hour\ Compressive\ Strength} \times Quantity\ of\ Concrete^{*} \times Bid\ Price^{**}$$

* The quantity for which the low compressive strength results represent.

** Item Bid Price; not Material cost.

ITEM	DESCRIPTION	UNIT
503001	PATCHING P.C.C PAVEMENT, 6’ TO 15’, TYPE A	SY
503002	PATCHING P.C.C PAVEMENT, 15’ TO 100’, TYPE B	SY
503004	PATCHING P.C.C. PAVEMENT (UNDERCUTTING)	SY-IN
503006	DOWEL BARS	EA
503008	PATCHING P.C.C. PAVEMENT, HIGH EARLY STRENGTH	SY

SECTION 504 - CRACK AND JOINT SEALING

504.01 Description. Clean and seal existing transverse joints, longitudinal joints, and/or pavement cracks in existing pavement, existing patches, or around new patch perimeters, in accordance with the Contract Documents and as directed by the Engineer.

504.02 Materials. Provide Materials as specified in:

Joint / Crack Sealant Material	Section 1042
Joint Backup Material	Section 1043

504.03 Construction.

504.03.1 Sealant Equipment. Use sealing Equipment specifically recommended by the manufacturer, compatible with the approved sealant.

504.03.2 Existing Sealant Removal. Remove any in-place sealant from existing joints using a vertical cutting edge tool. A power driven high pressure water blaster is also permitted. V-shaped “plow tools” are not approved for use.

Remove the existing sealant to the depth required to accommodate any separating and/or backup Material used, and provide the specified reservoir depth for the new sealant Material to be installed.

504.03.3 Refacing of Joints. Saw or reface existing joints using a power-driven concrete saw with diamond or abrasive blades to remove all old sealant from the joint faces and to expose new clean concrete and, if required, to cut the joint to the width and depth necessary to provide the joint reservoirs shown in the Contract Documents.

504.03.4 Cleaning Prior to Resealing. Following all sawing, resawing, or refacing operations on newly constructed and/or existing joints, thoroughly clean the joint faces and openings by sandblasting, followed by an oil-free air jet to remove all cuttings or debris remaining on the faces or in the joint openings. When sandblasting and air jetting is completed, the concrete joint surface receiving the new joint sealant shall be free of all tar and asphalt, all old sealant, all discoloration and stain, as well as any and all other forms of contamination of the pore structure, resulting in a clean, dry, newly exposed concrete surface.

Immediately prior to the placement of the backup Material and the sealant, clean the joints with a compressed air stream of at least 100 pounds per square inch measured at the source.

When the bottom of the joint opening to be sealed is formed by previously installed expansion joint material (such as at existing concrete patch locations), insert a nonreactive adhesive-backed tape in lieu of the backer rod. Place tape 1/8 inch wider than the nominal width of the joints.

Equip air compressors used for the purpose described above, with traps capable of removing moisture and oil from the air. Stop work when there is oil or moisture in the compressed air. Do not resume work until adjustments are made and the air stream is found to be free of such contaminants.

Under no conditions will the Contractor be permitted to place the sealant if there is dust, moisture, oil, or any other contaminants on that portion of the concrete that is to receive the joint sealant. Do not stretch the backer rod during insertion in the joint.

Protect the public from hazard or damage during the sandblasting and joint cleaning operations. Use rigidly supported plywood sheeting or other suitable Material and methods for this purpose, subject to approval by the Engineer.

During all operations, do not damage the subbase, curbs, shoulders, load transfer devices, or pavement. If such damage occurs, submit repair procedure for approval and perform repairs to the satisfaction of the Engineer, at no cost to the Department.

504.03.5 Limits of Joint Preparation. Limit the final stages of joint preparation, including air pressure cleaning of joints, and placement of separating and/or backup Material to the length of joint that can be resealed during a Day's production.

504.03.6 Installation of Hot-Poured Sealant. Provide a copy of and follow manufacturer's recommendations

pertaining to the heating and application of the sealant.

Consider the first gallon of material to flow out of the applicator wand at the beginning of the Day to be spoil and discard it into a container for proper disposal.

Place sealant at a uniform, specified depth and thickness. Seal the joints uniformly so that upon completion of the Work, the surface of the sealant Material is 1/4 inch ± 1/16 inch below the adjacent pavement surface. Refill all low joints before Final Acceptance. Remove any excess material on the surface of the pavement so that it is left in a clean condition. No traffic is permitted on the pavement in the area of the joints during the curing period.

Any failure of the sealed joint due to lack of adhesion or cohesion of joint material, improper or unsatisfactory workmanship by the Contractor, or damage by the Contractor's operations or traffic, will be cause for rejection. Submit repair procedure to the Engineer for approval. Perform all repairs at no cost to the Department.

504.04 Method of Measurement.

The quantity is the actual number of linear feet of cracks and joints sealed and accepted measured along the crack and/or joint, end to end.

Sealing of overcuts will not be measured and are considered incidental to the saw cutting Item.

504.05 Basis of Payment.

Linear foot payment constitutes full compensation for furnishing and placing hot-poured joint sealer as specified in the Contract Documents, backup Material (backer rod), for removal and disposal of existing joint sealer, for all joint resawing and refacing, for sandblast cleaning, air-blast cleaning, and for all labor, tools, Equipment, and incidentals necessary to complete the Work.

ITEM	DESCRIPTION	UNIT
504001	CRACK AND JOINT SEALING LESS THAN 3/4 INCH WIDE	LF
504002	CRACK AND JOINT SEALING, 3/4 INCH TO 1-3/4 INCH WIDE	LF

SECTION 505 - P.C.C. PATCHING, PARTIAL DEPTH

505.01 Description. Perform partial depth patching of spalls, potholes, corner breaks or other surface distress in Portland cement concrete pavements. Prepare the patch by removing existing damaged and/or disintegrated concrete from the area indicated in the Contract Documents and as directed by the Engineer.

505.02 Materials. Provide Materials as specified in:

P.C.C Patching Material, Partial Depth	Section 1023

505.03 Construction. Provide an American Concrete Institute (ACI) or National Ready Mix Concrete Association (NRMCA) certified concrete flatwork technician to supervise all finishing. Provide proof of the flatwork certification to the Engineer prior to concrete placement.

505.03.1 Preparation and Placement. Construct partial depth patches at locations shown in the Contract Documents. Make a saw cut of prescribed depth around the perimeter of the patch area to provide a vertical face at the edge. Break and remove concrete within the patch area to a depth required with tools that do not damage adjacent concrete until sound and clean concrete is exposed. Avoid fracturing the sound concrete below the patch and undercutting or spalling the patch boundaries during the concrete removal operation.

If a partial depth repair area abuts a working joint or crack that penetrates the full depth of the slab, place an insert, styrofoam, or other approved bond-breaking medium to maintain existing joint dimensions.

Air-blast clean the patch surface of the prepared concrete just prior to placement of the patch Material.

Mix and place the patch Material in accordance with the manufacturer's recommendations. The patch area can be opened to traffic once the patch Material compressive strength is equal to or greater than 2,000 pounds per square inch. If rapid set concrete is used, then the compressive strength of 2,000 pounds per square inch must be achieved in no more than 6 hours.

If unfavorable ambient temperature is predicted that would prevent accomplishing the desired strength in the desired timeframe, then reschedule the Work, subject to approval by the Engineer.

505.03.2 Joints. Maintain joints in the existing concrete pavement, transverse and longitudinal. Prepare and seal joints by tooling or sawing to meet the requirements of Section 504.

505.04 Method of Measurement. The quantity will be measured as the actual number of square yards per inch for the surface area and depth placed and accepted in the field. Measurement will not be made for patch areas constructed outside the limits marked in the field or outside the limits approved by the Engineer.

The quantities of joint sawing, sealing, backer rod, and maintenance of existing joints will not be measured and are considered incidental to this Item.

505.05 Basis of Payment. The quantity is paid at the Contract Unit Price square yard per inch. Price and payment constitutes full compensation for saw cutting and sealing the patch perimeter, removal of existing deteriorated concrete, cleaning and preparing the patch area, forming and maintaining existing pavement joints, and, furnishing and placing patch Material. Payment will not be made for patch areas constructed outside the limits marked in the field or outside the limits approved by the Engineer.

ITEM	DESCRIPTION	UNIT
505000	P.C.C PATCHING, PARTIAL DEPTH	SY/IN

DIVISION 600 - STRUCTURES

SECTION 601 PIPE CULVERTS

601.01 Description.

Furnish and install pipe Culverts and flared end sections where shown in the Contract Documents. This Work also includes the construction of connections to existing drainage inlets and manholes as may be required to complete the Work.

601.02 Materials. Provide Materials as specified in:

Reinforced concrete pipe	Section 1031
Thermoplastic pipe	Section 1031.04
Corrugated aluminum or steel pipe	Section 1031.01
Backfill	Section 1001
Flowable Fill	Section 1047

601.03 Construction.

601.03.1 Preconstruction Inspection

The Department and Contractor will inspect all existing pipes to be used in the final drainage system and agree on the condition prior to the start of construction. Video inspection to be performed by the Department. Repair or replace in-kind any existing pipes damaged due to Contractor operations at no cost to the Department.

601.03.2 Pipe Bedding

Excavate the pipe trench and construct bedding in accordance with Section 207 and the Contract Documents. Remove any unsuitable material encountered below the proposed bedding of the pipe and replace as directed by the Engineer.

601.03.3 Reinforced Concrete Pipe

A. Joints

1. Before laying the pipe in the trench, attach the rubber gasket to the spigot end of each pipe joint and set firmly against the shoulder around the entire circumference of the pipe joint. Prior to installation, the Contractor may apply a lubricant specified by the gasket manufacturer to the gasket for ease of installation.

2. Carefully control pipe handling after the gasket has been affixed to avoid bumping the gasket and thus displacing it or covering it with dirt or other foreign material. Remove any gasket so disturbed and reposition if displaced or replace if damaged. Apply sufficient pressure in making the joint to ensure that the joint is tight.

B. Defects

1. Field inspections will be made to evaluate issues that may affect long-term performance such as cracks, joint quality, and alignment.

2. The following defects in reinforced concrete pipe constitute poor workmanship, and the presence of any of them in any individual pipe shall be sufficient cause for rejection:

   a. Illegible brand

   b. Misalignment, both vertical and horizontal

   c. Spalls

d. Slabbing (large slabs of concrete peeling away from the sides with a straightening of the reinforcement)

e. Cracks greater than 0.1 inch in width

f. Crack widths greater than 0.01 inch in width and showing efflorescence or differential movement

g. Differential joint movement

h. Improper gasket placement

i. Joint leakage

j. Settlement

k. Joint separations greater than manufacturer's recommendation or as follows (whichever is less):

i. 12-36 inch diameter Round	0.75 inch
ii. 42 inch and larger diameter Round	1.25 inch
iii. All Elliptical	1.50 inch

C. Installing Pipe

1. Lay all pipe in accordance with the Contract Documents, requirements of ASTM D2321, or manufacturer's guidelines, whichever is more stringent, and in an upgrade direction. Lay the pipe with the lowest point of the inside diameter conforming to the flow line shown in the Contract Documents. Carefully lay all pipe with the bell ends upgrade, with the spigot ends fully entered into the adjoining bell, and true to the lines and grades shown in the Contract Documents or as directed by the Engineer. Remove and reinstall any pipe that is not in true alignment or that shows any settlement after placement.

601.03.4 Metal Culverts

A. Bands

1. Furnish all corrugated aluminum or corrugated steel pipe in lengths specified in the Contract Documents. If any specified length of pipe is divided into shorter sections for convenience, furnish approved connecting bands for field joints.

2. Construct bands so as to lap an equal portion of each of the pipe sections to be connected. Fasten bands at the ends by galvanized angles having minimum dimensions of 2 inch by 2 inch by 3/16 inch. Other equally effective methods of fastening the bands may be used if approved. Include an approved rubber gasket with all field joints to ensure a watertight joint. Do not use bituminous coated connecting bands.

B. Defects

1. 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. 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. Illegible brand

b. Uneven laps

c. Deflection greater than 7.5 percent

d. Elliptical shaping (circular pipe only)

e. Misalignment, both vertical and horizontal

f. Ragged or diagonal sheared edges

g. Loose, unevenly lined or spaced rivets

h. Imperfectly formed rivet heads

i. Unfinished ends

j. Lack of rigidity

k. Bruised, scaled, or broken protective coating

l. Dents or bends in the metal

m. Improperly seated bells/spigots

n. Bulging or hanging gaskets

o. Joint separations greater than manufacturer's recommendation or as follows (whichever is less):

i. 12-36 inch diameter Round 0.75 inch

ii. 42 inch diameter and Larger 1.25 inch

iii. All Elliptical 1.50 inch

C. Installing Pipe

1. Carefully handle all pipe during unloading and placing in position. Do not drag the pipe over the ground or over timbers or planks.

2. Strut pipes as recommended by the manufacturer. Place struts before the Embankment is placed and remove as recommended by the manufacturer and directed by the Engineer.

3. Where the pipe sections are joined on the Project, join the ends with a standard band bolted firmly in place.

4. Lay all pipe in an upgrade direction. Lay the pipe with the lowest point of the inside diameter conforming to the flow line shown in the Contract Documents. Remove and reinstall any pipe that is not in true alignment or that shows any detrimental settlement after laying.

601.03.5 High Density Polyethylene Pipe

A. Joints

1. Provide only watertight joints when installing pipe.

2. For type S or D pipes, use gasketed watertight bell/spigot or bell/bell couplers. Provide a joint system that has sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joint.

3. For type C pipe, use bell and spigot, split-collar, or screw-on collar couplings that are corrugated to match the pipe corrugations and that provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joint. For split-collar couplings, engage at least two full corrugations on each pipe section. Screw-on collars shall have a width of at least one-half the nominal diameter of the pipe.

B. Defects

1. Field inspections will be made to evaluate issues that may affect long-term performance such as cracks, joint quality, and alignment.

2. The following defects in plastic pipe constitute poor workmanship, and the presence of any of them in any individual pipe shall be sufficient cause for rejection:

a. Illegible brand

b. Deflection greater than 5 percent

c. Misalignment, both vertical and horizontal

d. Connections with a gap exceeding 3/16 inch

e. Cracking or tearing

f. Creases

g. Unpigmented or non-uniformly pigmented pipe

h. Joint separations greater than manufacturer's recommendation.

C. Installing Pipe

1. Install pipe per Contract Documents and in accordance with the requirements of ASTM D2321 or the manufacturer's published guidelines, whichever are more stringent.

2. Lay all pipe in an upgrade direction. Lay the pipe with the lowest point of the inside diameter conforming to the flow line shown in the Contract Documents. Lay all pipe carefully with the bell ends upgrade, with the spigot ends fully entered into the adjoining bell, and true to the lines and grades shown in the Contract Documents or as directed by the Engineer. Remove and relay any pipe that is not in true alignment or that shows any settlement after laying.

601.03.6 Backfill

A. Backfill pipe in accordance with Section 207. Where heavy construction equipment travels over the pipe, place a cover of material to a minimum depth of 4 feet over the pipe. When multiple pipes are placed side by side, provide a minimum of 18 inch between outside diameter of the pipes.

B. Place an initial backfill lift that does not exceed 12 inches of loose material and is not higher than the spring line of the pipe. Slice the Material into the haunches of the pipe using a shovel. Place a maximum of 8 inches of loose Material for each remaining lift. Take caution not to hit the pipe with any mechanical compaction Equipment or to disturb the alignment of the pipe.

C. Flowable Fill

1. Provide trench width that includes 6 inches between the trench wall and outside diameter of the pipe. When multiple pipes are placed side by side, provide a minimum of 6 inches between outside diameter of the pipes. Control floating of the pipe.

2. Place flowable fill equally to both sides of the pipe with no more than 1 foot height difference in placement on either side of a pipe.

601.03.7 Post Installation Inspection

A. The Department will video inspect new pipe runs after installation to confirm condition prior to acceptance. Clean pipe prior to video inspection and provide maintenance of traffic during the pipe video inspection as needed.

601.03.8 Cleaning Pipe

A. Submit the source for the cleaning water to the Engineer for approval. Use only water that is safe for all downstream environments.

B. Use Equipment and construction methods in accordance with the guidelines under Sewer Pipe Cleaning, latest edition, found in the National Association of Sewer Service Companies (NASSCO) Specifications. Operate Equipment in accordance with the manufacturer's instructions. The cleaning operation shall consist of up to three passes of the hydrocleaning Equipment. If three passes do not adequately clean the pipe, the Engineer may direct the Contractor to use other procedures covered by heavy pipe cleaning or other items of Work. Dispose of material removed during the pipe cleaning operation at a site approved by the Engineer.

C. Heavy Pipe Cleaning

1. Submit methods for heavy pipe cleaning to the Engineer for approval prior to beginning Work.

601.03.9 Pipe Repair

A. Utilize Equipment and construction methods in accordance with the requirements under Pressure Testing and Grouting of Sewer Joints, Laterals and Lateral Connections (using the Packer Method with Solution Grouts), latest edition, found in the NASSCO Specifications. Submit alternate methods and/or Equipment to the Engineer for approval.

601.04 Method of Measurement.

A. The quantity of pipe Culverts will be measured as the actual number of linear feet of each type of pipe placed and accepted, measured from end to end of pipe, including structure wall thickness, but excluding structure interior and flared end sections.

B. The quantity of flared end sections will be measured as the actual number placed and accepted.

C. The quantity of drainage pipe cleaned will be measured as the actual number of linear feet of pipe cleaned and accepted measured from end to end.

D. The quantity of heavy pipe cleaning will be measured as the actual number of hours the Contractor is actively engaged in heavy pipe cleaning Work.

E. The quantity of pipe joints pressure grouted will be measured as the actual number of joints grouted and accepted.

F. The limits of excavation will be measured in accordance with Section 207.

601.05 Basis of Payment.

A. The quantity of pipe Culverts will be paid for at the Contract Unit Price per linear foot for each type of pipe. 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 reinforced concrete pipes; for all cribbing or foundation treatment necessary to prevent settlement; for the replacement of any pipe which is not true in alignment or which shows any settlement after laying; for excavating (excluding rock), backfilling, and compacting; for cribbing, shoring, sheeting; for cleaning the pipe and providing maintenance of traffic for the pipe video inspection; and for all labor, Equipment, tools, and incidentals required to complete the Work. Payment for excavation and replacement of unsuitable material encountered below the pipe foundation bedding will be provided for under Section 207. Payment for rock excavation will be provided for under Section 207.

B. The quantity of pipe cleaned will be paid for at the Contract Unit Price per linear foot. Price and payment will constitute full compensation for furnishing Equipment and water, disposing of removed material, and for all labor, Equipment, tools, and incidentals to complete the Work.

C. The quantity of heavy pipe cleaning will be paid for at the Contract Unit Price per hour. Price and payment will constitute full compensation for furnishing Equipment and water, disposing of removed material, and for all labor, Equipment, tools, and incidentals to complete the Work.

D. The quantity of pipe joints pressure grouted will be paid for at the Contract Unit Price per each. Price and payment will constitute full compensation for furnishing and placing all Materials, pressure testing the joint, removing excess sealant Material in the pipe, and for all labor, Equipment, tools, and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
601000	CLEANING DRAINAGE PIPE, 15"-24" DIAMETER	LF
601001	CLEANING DRAINAGE PIPE, GREATER THAN 24" DIAMETER	LF
601002	HEAVY CLEANING OF DRAINAGE PIPE	HOUR
601003	PRESSURE GROUTING PIPE JOINTS, 15"-24" DIAMETER	EACH

601004	PRESSURE GROUTING PIPE JOINTS, GREATER THAN 24" DIAMETER	EACH
601010	REINFORCED CONCRETE PIPE, 12", CLASS III	LF
601011	REINFORCED CONCRETE PIPE, 15", CLASS III	LF
601012	REINFORCED CONCRETE PIPE, 18", CLASS III	LF
601013	REINFORCED CONCRETE PIPE, 21", CLASS III	LF
601014	REINFORCED CONCRETE PIPE, 24", CLASS III	LF
601015	REINFORCED CONCRETE PIPE, 27", CLASS III	LF
601016	REINFORCED CONCRETE PIPE, 30", CLASS III	LF
601017	REINFORCED CONCRETE PIPE, 33", CLASS III	LF
601018	REINFORCED CONCRETE PIPE, 36", CLASS III	LF
601019	REINFORCED CONCRETE PIPE, 42", CLASS III	LF
601020	REINFORCED CONCRETE PIPE, 48", CLASS III	LF
601021	REINFORCED CONCRETE PIPE, 54", CLASS III	LF
601022	REINFORCED CONCRETE PIPE, 60", CLASS III	LF
601023	REINFORCED CONCRETE PIPE, 66", CLASS III	LF
601024	REINFORCED CONCRETE PIPE, 72", CLASS III	LF
601025	REINFORCED CONCRETE PIPE, 78", CLASS III	LF
601026	REINFORCED CONCRETE PIPE, 84", CLASS III	LF
601027	REINFORCED CONCRETE PIPE, 90", CLASS III	LF
601028	REINFORCED CONCRETE PIPE, 96", CLASS III	LF
601029	REINFORCED CONCRETE PIPE, 102", CLASS III	LF
601030	REINFORCED CONCRETE PIPE, 108", CLASS III	LF
601031	REINFORCED CONCRETE PIPE, 12", CLASS IV	LF
601032	REINFORCED CONCRETE PIPE, 15", CLASS IV	LF
601033	REINFORCED CONCRETE PIPE, 18", CLASS IV	LF
601034	REINFORCED CONCRETE PIPE, 21", CLASS IV	LF
601035	REINFORCED CONCRETE PIPE, 24", CLASS IV	LF
601036	REINFORCED CONCRETE PIPE, 27", CLASS IV	LF
601037	REINFORCED CONCRETE PIPE, 30", CLASS IV	LF
601038	REINFORCED CONCRETE PIPE, 33", CLASS IV	LF
601039	REINFORCED CONCRETE PIPE, 36", CLASS IV	LF
601040	REINFORCED CONCRETE PIPE, 42", CLASS IV	LF
601041	REINFORCED CONCRETE PIPE, 48", CLASS IV	LF
601042	REINFORCED CONCRETE PIPE, 54", CLASS IV	LF

601043	REINFORCED CONCRETE PIPE, 60", CLASS IV	LF
601044	REINFORCED CONCRETE PIPE, 66", CLASS IV	LF
601045	REINFORCED CONCRETE PIPE, 72", CLASS IV	LF
601046	REINFORCED CONCRETE PIPE, 78", CLASS IV	LF
601047	REINFORCED CONCRETE PIPE, 84", CLASS IV	LF
601048	REINFORCED CONCRETE PIPE, 90", CLASS IV	LF
601049	REINFORCED CONCRETE PIPE, 96", CLASS IV	LF
601050	REINFORCED CONCRETE PIPE, 102", CLASS IV	LF
601051	REINFORCED CONCRETE PIPE, 108", CLASS IV	LF
601052	REINFORCED CONCRETE PIPE, 12", CLASS V	LF
601053	REINFORCED CONCRETE PIPE, 15", CLASS V	LF
601054	REINFORCED CONCRETE PIPE, 18", CLASS V	LF
601055	REINFORCED CONCRETE PIPE, 21", CLASS V	LF
601056	REINFORCED CONCRETE PIPE, 24", CLASS V	LF
601057	REINFORCED CONCRETE PIPE, 27", CLASS V	LF
601058	REINFORCED CONCRETE PIPE, 30", CLASS V	LF
601059	REINFORCED CONCRETE PIPE, 33", CLASS V	LF
601060	REINFORCED CONCRETE PIPE, 36", CLASS V	LF
601061	REINFORCED CONCRETE PIPE, 42", CLASS V	LF
601062	REINFORCED CONCRETE PIPE, 48", CLASS V	LF
601063	REINFORCED CONCRETE PIPE, 54", CLASS V	LF
601064	REINFORCED CONCRETE PIPE, 60", CLASS V	LF
601065	REINFORCED CONCRETE PIPE, 66", CLASS V	LF
601066	REINFORCED CONCRETE PIPE, 72", CLASS V	LF
601067	REINFORCED CONCRETE PIPE, 78", CLASS V	LF
601068	REINFORCED CONCRETE PIPE, 84", CLASS V	LF
601069	REINFORCED CONCRETE PIPE, 90", CLASS V	LF
601070	REINFORCED CONCRETE PIPE, 96", CLASS V	LF
601071	REINFORCED CONCRETE PIPE, 102", CLASS V	LF
601072	REINFORCED CONCRETE PIPE, 108", CLASS V	LF
601100	REINFORCED CONCRETE ELLIPTICAL PIPE, 14"X23", CLASS III	LF
601101	REINFORCED CONCRETE ELLIPTICAL PIPE, 19"X30", CLASS III	LF
601102	REINFORCED CONCRETE ELLIPTICAL PIPE, 22"X34", CLASS III	LF
601103	REINFORCED CONCRETE ELLIPTICAL PIPE, 24"X38", CLASS III	LF

601104	REINFORCED CONCRETE ELLIPTICAL PIPE, 27"X42", CLASS III	LF
601105	REINFORCED CONCRETE ELLIPTICAL PIPE, 29"X45", CLASS III	LF
601106	REINFORCED CONCRETE ELLIPTICAL PIPE, 32"X49", CLASS III	LF
601107	REINFORCED CONCRETE ELLIPTICAL PIPE, 34"X53", CLASS III	LF
601108	REINFORCED CONCRETE ELLIPTICAL PIPE, 38"X60", CLASS III	LF
601109	REINFORCED CONCRETE ELLIPTICAL PIPE, 43"X68", CLASS III	LF
601110	REINFORCED CONCRETE ELLIPTICAL PIPE, 48"X76", CLASS III	LF
601111	REINFORCED CONCRETE ELLIPTICAL PIPE, 53"X83", CLASS III	LF
601112	REINFORCED CONCRETE ELLIPTICAL PIPE, 58"X91", CLASS III	LF
601113	REINFORCED CONCRETE ELLIPTICAL PIPE, 63"X98", CLASS III	LF
601114	REINFORCED CONCRETE ELLIPTICAL PIPE, 68"X106", CLASS III	LF
601115	REINFORCED CONCRETE ELLIPTICAL PIPE, 14"X23", CLASS IV	LF
601116	REINFORCED CONCRETE ELLIPTICAL PIPE, 19"X30", CLASS IV	LF
601117	REINFORCED CONCRETE ELLIPTICAL PIPE, 22"X34", CLASS IV	LF
601118	REINFORCED CONCRETE ELLIPTICAL PIPE, 24"X38", CLASS IV	LF
601119	REINFORCED CONCRETE ELLIPTICAL PIPE, 27"X42", CLASS IV	LF
601120	REINFORCED CONCRETE ELLIPTICAL PIPE, 29"X45", CLASS IV	LF
601121	REINFORCED CONCRETE ELLIPTICAL PIPE, 32"X49", CLASS IV	LF
601122	REINFORCED CONCRETE ELLIPTICAL PIPE, 34"X53", CLASS IV	LF
601123	REINFORCED CONCRETE ELLIPTICAL PIPE, 38"X60", CLASS IV	LF
601124	REINFORCED CONCRETE ELLIPTICAL PIPE, 43"X68", CLASS IV	LF
601125	REINFORCED CONCRETE ELLIPTICAL PIPE, 48"X76", CLASS IV	LF
601126	REINFORCED CONCRETE ELLIPTICAL PIPE, 53"X83", CLASS IV	LF
601127	REINFORCED CONCRETE ELLIPTICAL PIPE, 58"X91", CLASS IV	LF
601128	REINFORCED CONCRETE ELLIPTICAL PIPE, 63"X98", CLASS IV	LF
601129	REINFORCED CONCRETE ELLIPTICAL PIPE, 68"X106", CLASS IV	LF
601130	REINFORCED CONCRETE ELLIPTICAL PIPE, 14"X23", CLASS V	LF
601131	REINFORCED CONCRETE ELLIPTICAL PIPE, 19"X30", CLASS V	LF
601132	REINFORCED CONCRETE ELLIPTICAL PIPE, 22"X34", CLASS V	LF
601133	REINFORCED CONCRETE ELLIPTICAL PIPE, 24"X38", CLASS V	LF
601134	REINFORCED CONCRETE ELLIPTICAL PIPE, 27"X42", CLASS V	LF
601135	REINFORCED CONCRETE ELLIPTICAL PIPE, 29"X45", CLASS V	LF
601136	REINFORCED CONCRETE ELLIPTICAL PIPE, 32"X49", CLASS V	LF
601137	REINFORCED CONCRETE ELLIPTICAL PIPE, 34"X53", CLASS V	LF

601138	REINFORCED CONCRETE ELLIPTICAL PIPE, 38"X60", CLASS V	LF
601139	REINFORCED CONCRETE ELLIPTICAL PIPE, 43"X68", CLASS V	LF
601140	REINFORCED CONCRETE FLARED END SECTION, 12"	EACH
601141	REINFORCED CONCRETE FLARED END SECTION, 15"	EACH
601142	REINFORCED CONCRETE FLARED END SECTION, 18"	EACH
601143	REINFORCED CONCRETE FLARED END SECTION, 21"	EACH
601144	REINFORCED CONCRETE FLARED END SECTION, 24"	EACH
601145	REINFORCED CONCRETE FLARED END SECTION, 27"	EACH
601146	REINFORCED CONCRETE FLARED END SECTION, 30"	EACH
601147	REINFORCED CONCRETE FLARED END SECTION, 33"	EACH
601148	REINFORCED CONCRETE FLARED END SECTION, 36"	EACH
601149	REINFORCED CONCRETE FLARED END SECTION, 42"	EACH
601150	REINFORCED CONCRETE FLARED END SECTION, 48"	EACH
601151	REINFORCED CONCRETE FLARED END SECTION, 54"	EACH
601152	REINFORCED CONCRETE FLARED END SECTION, 60"	EACH
601153	REINFORCED CONCRETE FLARED END SECTION, 66"	EACH
601154	REINFORCED CONCRETE FLARED END SECTION, 72"	EACH
601155	REINFORCED CONCRETE FLARED END SECTION, 78"	EACH
601156	REINFORCED CONCRETE FLARED END SECTION, 84"	EACH
601157	REINFORCED CONCRETE FLARED END SECTION, 90"	EACH
601158	REINFORCED CONCRETE FLARED END SECTION, 96"	EACH
601170	REINFORCED CONCRETE FLARED END SECTION, 14" X 23"	EACH
601171	REINFORCED CONCRETE FLARED END SECTION, 19" X 30"	EACH
601172	REINFORCED CONCRETE FLARED END SECTION, 22" X 34"	EACH
601173	REINFORCED CONCRETE FLARED END SECTION, 24" X 38"	EACH
601174	REINFORCED CONCRETE FLARED END SECTION, 27" X 42"	EACH
601175	REINFORCED CONCRETE FLARED END SECTION, 29" X 45"	EACH
601176	REINFORCED CONCRETE FLARED END SECTION, 32" X 49"	EACH
601177	REINFORCED CONCRETE FLARED END SECTION, 34" X 53"	EACH
601178	REINFORCED CONCRETE FLARED END SECTION, 38" X 60"	EACH
601179	REINFORCED CONCRETE FLARED END SECTION, 43" X 68"	EACH
601180	REINFORCED CONCRETE FLARED END SECTION, 48" X 76"	EACH
601190	PVC PIPE, 4”	LF
601191	PVC PIPE, 6”	LF

601192	PVC PIPE, 8”	LF
601193	PVC PIPE, 10”	LF
601194	PVC PIPE, 12”	LF
601195	PVC PIPE, 14”	LF
601196	PVC PIPE, 16”	LF
601197	PVC PIPE, 18”	LF
601198	PVC PIPE, 20”	LF
601199	PVC PIPE, 24”	LF
601210	CORRUGATED POLYETHYLENE PIPE, TYPE C, 8"	LF
601211	CORRUGATED POLYETHYLENE PIPE, TYPE C, 10"	LF
601212	CORRUGATED POLYETHYLENE PIPE, TYPE C, 12"	LF
601213	CORRUGATED POLYETHYLENE PIPE, TYPE C, 15"	LF
601214	CORRUGATED POLYETHYLENE PIPE, TYPE C, 18"	LF
601215	CORRUGATED POLYETHYLENE PIPE, TYPE C, 21"	LF
601216	CORRUGATED POLYETHYLENE PIPE, TYPE C, 24"	LF
601217	CORRUGATED POLYETHYLENE PIPE, TYPE S, 8"	LF
601218	CORRUGATED POLYETHYLENE PIPE, TYPE S, 10"	LF
601219	CORRUGATED POLYETHYLENE PIPE, TYPE S, 12"	LF
601220	CORRUGATED POLYETHYLENE PIPE, TYPE S, 15"	LF
601221	CORRUGATED POLYETHYLENE PIPE, TYPE S, 18"	LF
601222	CORRUGATED POLYETHYLENE PIPE, TYPE S, 21"	LF
601223	CORRUGATED POLYETHYLENE PIPE, TYPE S, 24"	LF
601224	CORRUGATED POLYETHYLENE PIPE, TYPE S, 30"	LF
601225	CORRUGATED POLYETHYLENE PIPE, TYPE S, 36"	LF
601226	CORRUGATED POLYETHYLENE PIPE, TYPE S, 42"	LF
601227	CORRUGATED POLYETHYLENE PIPE, TYPE S, 48"	LF
601228	CORRUGATED POLYETHYLENE PIPE, TYPE S, 54"	LF
601229	CORRUGATED POLYETHYLENE PIPE, TYPE S, 60"	LF
601240	CORRUGATED POLYETHYLENE FLARED END SECTION, 12"	EACH
601241	CORRUGATED POLYETHYLENE FLARED END SECTION, 15"	EACH
601242	CORRUGATED POLYETHYLENE FLARED END SECTION, 18"	EACH
601243	CORRUGATED POLYETHYLENE FLARED END SECTION, 24"	EACH
601244	CORRUGATED POLYETHYLENE FLARED END SECTION, 30"	EACH
601245	CORRUGATED POLYETHYLENE FLARED END SECTION, 36"	EACH

601250	STEEL REINFORCED POLYETHYLENE PIPE, 60”	LF
601251	STEEL REINFORCED POLYETHYLENE PIPE, 66”	LF
601252	STEEL REINFORCED POLYETHYLENE PIPE, 72”	LF
601253	STEEL REINFORCED POLYETHYLENE PIPE, 84”	LF
601254	STEEL REINFORCED POLYETHYLENE PIPE, 96”	LF
601255	STEEL REINFORCED POLYETHYLENE PIPE, 120”	LF
601260	GALVANIZED CORRUGATED STEEL PIPE, 12", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601261	GALVANIZED CORRUGATED STEEL PIPE, 15", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601262	GALVANIZED CORRUGATED STEEL PIPE, 18", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601263	GALVANIZED CORRUGATED STEEL PIPE, 21", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601264	GALVANIZED CORRUGATED STEEL PIPE, 24", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601280	GALVANIZED CORRUGATED ALUMINUM PIPE, 12", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601281	GALVANIZED CORRUGATED ALUMINUM PIPE, 15", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601282	GALVANIZED CORRUGATED ALUMINUM PIPE, 18", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601283	GALVANIZED CORRUGATED ALUMINUM PIPE, 21", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF
601284	GALVANIZED CORRUGATED ALUMINUM PIPE, 24", 16 GAGE, 2 2/3" X1/2" CORRUGATION	LF

SECTION 602 – DRAINAGE STRUCTURES

602.01 Description. Construct, furnish, replace, adjust, and/or repair drainage inlets, drainage inlet frames and grates, manholes, manhole frames and covers, and junction boxes.

602.02 Materials. Provide Materials as specified in the following:

Graded Aggregate Base Course	Section 1005
Portland Cement Concrete, Class A or B	Section 1022
Expansion Joint Material	Section 1042
Bar Reinforcement	Section 611 and Section 1037
Curing Compound	Section 1022
Welding	AASHTO / AWS D1.5 Welding Code
Castings	Section 1039.07
Steps	AASHTO M199, and ASTM C478,
Polypropylene	ASTM D4101
Borrow, Type C	Section 1001
Topsoil	Section 908
Seeding	Section 908
Rectangular precast Structures	ASTM C913
Round precast Structures	AASHTO M199

602.03 Construction.

A. *Working Drawings:*

1. Prior to fabrication, submit Working Drawings that include the quantity and locations of the following:
    a. Drainage inlets, manholes, and junction boxes that do not conform to the requirements of the Contract Documents. Include design calculations ensuring the proposed Structure has been designed for all loads including the HS-20 live load.
    b. Drainage inlet frames and grates and manhole frames and covers that do not conform to the requirements of the Contract Documents.
    c. Drainage inlet frames and manhole frames that require adjustments or repair.
    d. Junction boxes that require repair.
2. For locations that require repair, adjusting, or replacement, include field measurements to determine the exact sizes of the drainage inlet frames and grates and manhole frames and covers prior to placing order.
3. For locations that require repair of existing junction boxes, include field measurements to determine the exact sizes of top cover slab and hinge. Also include all parts and fittings for installation.
4. Use drainage inlet frames and grates and manhole frames and covers that are capable of meeting or exceeding HS-20 load rating requirements in accordance with AASHTO M306.
5. Use Portland Cement Concrete, Class A for drainage inlets, manholes, and junction boxes that do not conform to the requirements of the Standard Construction Details; use of Class B concrete is otherwise permitted.

B. *Furnish and Construct Drainage Inlets, Manholes and Junction Boxes:*

1. Excavate to the required depth in accordance with Section 207.03. Compact the foundation upon which the concrete floor of the Structure is to be placed to a firm, even surface to the acceptance of the Engineer.

2. Place the Structure as shown in the Contract Documents. Use cast-in-place construction for drainage Structures that tie in to existing pipes and Structures unless otherwise specified in the Contract Documents or if the Engineer approves the use of precast Structures. Use precast Structures for all new construction unless otherwise specified in the Contract Documents or directed by the Engineer.

   a. Construct cast-in-place reinforced concrete Structures in accordance with Section 610.

   b. Construct precast reinforced concrete Structures in accordance with Section 612.

   c. Provide precast reinforced concrete round manhole riser sections and appurtenances in accordance with AASHTO M199.

3. Set the frames of castings in concrete.

4. Install steps on the backwall for all drainage inlets and manholes, and junction boxes that utilize a removable top slab, as specified in the Contract Documents or are 4 feet or more in depth, measured from the top of grate or cover to the invert of the lowest pipe. Provide a minimum embedment of 3 inches in the wall and ensure that the steps protrude out 6 inches from the wall. Begin steps within 24 inches of the top of grate/lid and end steps no more than 12 inches above the lowest invert except where a pipe is in the backwall. Space steps vertically at 12 inch intervals.

5. Ensure inlet and outlet pipes are the same size and type as the connecting pipes shown in the Contract Documents and that pipes extend through the walls and are flush with the inside of the wall. When the end of a reinforced concrete pipe is cut off, ensure that the end is cut clean and smoothly finished with mortar so that no bar reinforcement remains exposed. Fill any space between the pipe and the walls of the drainage inlet with non-shrink grout conforming to the requirements of Section 1047, with a minimum strength of 5000 pounds per square inch. Ensure that the greatest dimension of the opening in the drainage inlet for the pipe is no greater than the outside pipe diameter plus 4 inches.

6. Pour flow channel.

7. Backfill the area around drainage inlets and manholes with Borrow Type C Material to the required elevation in accordance with Section 207. Approval is required prior to the placement of any backfill.

C. *Furnish and Replace Drainage Inlet Frames and Grates and Manhole Frames and Covers:*

1. Drainage Inlet Grates and Manhole Covers

   a. Remove and dispose of non-compliant drainage inlet grates and manhole covers and install new grates and covers as per the Contract Documents.

2. Drainage Inlet and Manhole Frames

   a. Saw cut existing bituminous concrete or Portland Cement Concrete pavement a minimum 2 feet from face of drainage inlet.

   b. Excavate materials from perimeter of the drainage inlet or manhole to the required depth in accordance with Section 207.03. Dispose of waste materials in accordance with Section 106.08.

   c. Prepare subgrade for patching to match existing pavement section.

   d. Pour flow channel if specified in the Contract Documents, or as directed by the Engineer.

   e. Place forms for the new drainage inlet or manhole top unit to accommodate the replacement frame in accordance with the Contract Documents.

      i. Place required bar reinforcement.

      ii. Placing the grate on bricks or blocks is not permitted.

f. Place expansion joint Material at the outside limits of the drainage inlet curb section.

g. Place Portland Cement Concrete for drainage inlet or manhole top unit in accordance with the Contract Documents.

i. Finish Portland Cement Concrete in accordance with Section 610.03.H.

ii. Cure in accordance with Section 610.03.I.

iii. Remove forms in accordance with Section 610.03.K.

h. Backfill the area around drainage inlets and manholes in accordance with Section 602.03.B.7.

3. Disposal

a. Transport and unload removed drainage inlet frames and grates and manhole frames and covers to the Department's District Maintenance Yard as specified in the Contract Documents or as directed by the Engineer.

D. *Furnish, Adjust and Repair Drainage Inlet Frames and Manhole Frames*

1. Remove covers of drainage inlets or manholes for inspection by Engineer.

2. Saw cut existing bituminous concrete or Portland Cement Concrete pavement a minimum 2 feet from face of drainage inlet.

3. Excavate and remove existing castings.

a. Take care to not damage castings. Clean and set aside for reuse.

b. Replace castings where specified.

4. If existing Structure is in good condition, as determined by the Engineer, adjust the drainage inlet frame and grate or manhole frame and cover to grade.

a. Set forms for adjusting frame such that frame is encased in Portland Cement Concrete, Class B.

b. Placing frame on bricks, blocks or other materials will not be permitted.

5. If existing Structure is in poor condition, as determined by the Engineer, repair as directed.

a. Keep silt and debris away from Structure until Work is complete.

b. Set frame as directed in Section 602.03.D.4.a.

6. Install steps on the back wall of drainage inlets or manholes as needed in accordance with Section 602.03.B.4.

7. Pour flow channel if specified in the Contract Documents and as directed by the Engineer.

8. Form drainage inlet or manhole top unit as shown in the Contract Documents or approved Working Drawings.

9. Place concrete in accordance with Section 610.03.E.

a. Cure Concrete in accordance with Section 610.03.I.

b. Remove forms in accordance to Section 610.03.K.

10. Backfill the area around drainage inlets and manholes in accordance with Section 602.03.B.7.

11. Dispose of materials in accordance with Section 602.03.C.3.

E. *Furnish and Repair Junction Boxes*

1. Where applicable, follow provisions listed under Section 602.03.D.

F. *Adjust Drainage Inlets and Manholes*

1. Patches for drainage inlets and manholes adjusted after the paving operations will require a perimeter reservoir and will be sealed in accordance to Section 504.

602.04 Method of Measurement.

A. The quantity of drainage inlets, manholes, and junction boxes will be measured as the actual number of each installed and accepted. Inlet and outlet pipe will be measured with the adjoining pipe under the appropriate section for the size and type of pipe installed. Drainage inlet frames and grates and manhole frames and covers are included in the Items and will not be measured.

B. The quantity of drainage inlet grate, drainage inlet frame, manhole cover, and manhole frame replaced will be measured as the actual number of each that is installed and accepted.

C. The quantity of adjust and repair existing drainage inlets, double drainage inlets, manholes, and junction boxes will be measured as the actual number of each adjusted and/or repaired and accepted.

1. Units repaired from the top of the unit frame to a depth of 3 feet below will be paid at Contract Unit Price.

2. Units repaired below a depth greater than 3 feet to not more than 4.5 foot will be paid for at 1.5 times the Contract Unit Price.

3. Units repaired below a depth greater than 4.5 feet will be paid for at 2 times the Contract Unit Price.

4. In no case will the payment exceed 2 times the Contract Unit Price regardless of the depth of repairs.

D. The quantity of special drainage inlets, special junction boxes, and special manholes placed and accepted will not be measured.

602.05 Basis of Payment.

The quantities will be paid at the respective Contract Unit Prices for the Items installed, completed in place, and accepted. Price and payment will constitute full compensation for furnishing, hauling, and installing all Materials; for excavation, backfilling, and compacting, and for all labor, Equipment, tools, and incidentals including, but not limited to, saw cutting of the existing bituminous concrete or Portland Cement Concrete and disposal of waste materials to complete the Work as specified.

Submit the breakout sheet included in the Proposal that lists all of the special drainage inlets, special junction boxes, and special manholes under their respective Items. Fill in a Unit Price for each special drainage inlet, special junction box, and special manhole. The lump sum bid for the respective pay Items will be the sum of the price for all Structures listed on the breakout sheet. Attach the breakout sheet to the Bid Proposal. Failure to submit the breakout sheet with the Bid Proposal will result in the Bid Proposal being declared non-responsive and being rejected.

ITEM	DESCRIPTION	UNIT
602000	DRAINAGE INLET, 17.625” X 11.625”	EA
602001	DRAINAGE INLET, 24” X 24”	EA
602002	DRAINAGE INLET, 34” X 18”	EA
602003	DRAINAGE INLET, 34” X 24”	EA
602004	DRAINAGE INLET, 48” X 30”	EA
602005	DRAINAGE INLET, 48” X 48”	EA
602006	DRAINAGE INLET, 66” X 30”	EA
602007	DRAINAGE INLET, 66” X 48”	EA

602008	DRAINAGE INLET, 66” X 66”	EA
602009	DRAINAGE INLET, 72” X 24”	EA
602010	DRAINAGE INLET, 72” X 48”	EA
602011	DRAINAGE INLET, 72” X 72”	EA
602012	DRAINAGE INLET, SPECIAL	EA
602013	DRAINAGE INLET, SPECIAL	LS
602030	MANHOLE, 48” X 30”	EA
602031	MANHOLE, 48” X 48”	EA
602032	MANHOLE, 66” X 30”	EA
602033	MANHOLE, 66” X 48”	EA
602034	MANHOLE, 66” X 66”	EA
602035	MANHOLE, ROUND	EA
602036	MANHOLE, SPECIAL	EA
602037	MANHOLE, SPECIAL	LS
602060	JUNCTION BOX, 48” X 30”	EA
602061	JUNCTION BOX, 48” X 48”	EA
602062	JUNCTION BOX, 66” X 30”	EA
602063	JUNCTION BOX, 66” X 48”	EA
602064	JUNCTION BOX, 66” X 66”	EA
602065	JUNCTION BOX, SPECIAL	EA
602066	JUNCTION BOX, SPECIAL	LS
602100	REPLACE DRAINAGE INLET GRATE(S)	EA
602101	REPLACE DRAINAGE INLET FRAME(S)	EA
602102	REPLACE MANHOLE COVER(S)	EA
602103	REPLACE MANHOLE FRAME(S)	EA
602130	ADJUSTING AND REPAIRING EXISTING DRAINAGE INLET	EA
602131	ADJUSTING AND REPAIRING EXISTING DOUBLE DRAINAGE INLET	EA
602132	ADJUSTING AND REPAIRING EXISTING MANHOLE	EA
602133	REPAIRING EXISTING JUNCTION BOX	EA

SECTION 604 – TEMPORARY WORKS

604.01 Description. Construct and remove temporary facilities used in the execution of the Work. These temporary works may include Falsework, cofferdams, shoring, water control systems, and jacking systems.

604.02 Materials.

Steel	Section 1039
Timber	Section 1041
Sheet Piles	Section 1032
Form Oil	Section 1049

604.03 Construction.

604.03.1 Working Drawings

A. Prepare and submit Working Drawings for the temporary works at least 30 Days in advance of beginning the Work in accordance with Section 105.04. Such drawings must include Materials list, erection scheme, design calculations, and supporting data in sufficient detail to allow a structural review of the proposed design of a temporary work. Drawings and calculations must be sealed by a Professional Engineer registered in the State of Delaware, and must be approved by the Engineer prior to fabrication.

B. Have a registered Professional Engineer design the temporary works according to *AASHTO LRFD Bridge Design Specifications* or the *Guide Design Specifications for Bridge Temporary Works*, or to other design codes as specified in the Contract Documents. Design must consider all applicable loads including, but not limited to, wind loads, dead loads, live loads, etc.

C. Unless otherwise noted in the Contract Documents, the minimum under-clearance over roadways (travel way and shoulder) shall be as follows:

1. 14.5 feet for interstate and other controlled access highways
2. 14.0 feet for all other roadways

No portion of the temporary works system (including connection devices) shall encroach on under-clearances.

D. Start construction only after the Working Drawings have been approved. Construct temporary works in conformance with the approved Working Drawings. Verify that the quality of the Materials and Work employed are consistent with the design.

E. Remove and retain, or dispose of, temporary works upon completion of their use. Restore the area to its original or planned condition and dispose of debris.

604.03.2 Falsework and Formwork

A. Furnish rigid and strong Falsework and forms to safely support the imposed loads and produce the lines and grades indicated. Impart the required surface texture and rustication with forms and provide uniformity of color of formed surfaces.

B. Limit loads of Falsework onto other Structures.

C. For roadways remaining open to traffic during construction, provide a horizontal clearance of 5 feet greater than the width of the approach traveled way.

D. Construct Falsework and set grades that allow for anticipated settlement and deflection, provide the vertical alignment and camber indicated for the permanent Structure, allow for minor adjustments during the placement of concrete or structural steel, and allow for the gradual release of the Falsework. Attach an approved indicator to the forms in a manner to indicate any settlement, movement, or deflection in the

Falsework. Provide for accurate measurement of Falsework settlement during the placing and curing of the concrete.

E. Support Falsework or Formwork for deck slabs on girder bridges directly on the girders. Brace and tie girders to resist forces that would cause rotation or torsion in the girders. Do not weld Falsework support brackets or braces to structural steel members or reinforcing steel unless where specified or directed.

F. For concrete surfaces that will be exposed to view, provide Formwork that will produce a smooth surface of uniform texture and color. Arrange panels lining of such forms so that the joint lines form a symmetrical pattern conforming to the general lines of the Structure. Use the same type of form lining material throughout each element of a Structure. Use rigid forms to ensure the undulation of the concrete surface is less than 1/8 inch when checked with a 60-inch straightedge or template. Fillet sharp corners with approximately 3/4 inch chamfer strips.

G. If form liners are specified in the Contract Documents, use form lining pieces as large as possible. Arrange panels lining such forms so that the joint lines form a symmetrical pattern conforming to the general lines of the Structure. Ensure that joints are solidly backed, butted together tightly, and sealed with approved crack fillers. Use the same type of form lining material throughout each element of a Structure.

H. Set and hold forms true to the dimensions, lines, and grades of the Structure prior to and during the placement of concrete. Bevel or chamfer at projections, such as copings, to ensure easy removal. Clean forms, inspect for damage and, if necessary, repair prior to reuse. Discontinue use of forms that appear to be defective until defects are corrected. Treat forms with form oil or other approved release agent before placing the reinforcing steel. Do not use material that adheres to or discolors the concrete.

I. Construct metal ties or anchorages within the forms to ensure that they may be removed to a depth of at least 1 inch from the face without injury to the concrete. Design fittings for metal ties to minimize the size of the cavities remaining after their removal. Fill the cavities with cement mortar and leave the surface sound, smooth, even, and uniform in color.

J. When epoxy-coated reinforcing steel is required, use embedded ties, anchorages, or spreaders of corrosion-resistant Material or coated with a dielectric Material. Remove wood blocks and bracing within the forms and in no case leave any portion of the wood forms in the concrete.

K. In narrow walls and columns, where the bottom of the form is inaccessible, provide an access opening in the forms for cleaning out extraneous material immediately before placing the concrete. For thin wall construction, daylight forms at intervals not greater than 10 feet vertically to permit free access to the forms for the purpose of inspecting, working, and vibrating the concrete.

L. Design and fabricate cardboard tubes, which are placed in forms to produce voids in concrete slabs and box beams. Fabricate the outside layers of the tubes to be fully waterproof. Protect such tubes from the weather, and store and install by methods that prevent distortion or damage prior to concrete placement. Prevent fresh concrete from entering the tubes during concrete placement. Cover the ends of tube forms with mortar-tight and waterproof caps. Use a premolded rubber joint filler, 1/4 inch in thickness, around the perimeter of the caps to allow expansion when wood or other expandable material is used for capping tubes. Provide a polyvinyl chloride (PVC) vent tube near each end of each tube. Construct these vents, provide positive venting of the voids, and trim the vent tubes to within 5/8 inch of the bottom surface of the finished concrete after removing the exterior form. Anchor or tie tube forms to prevent displacement of the tubes during concrete placement. Styrofoam blocks may be used in lieu of cardboard tubes, provided they are properly anchored to prevent displacement during pouring.

M. Deposit concrete in the forms after all Work related to constructing the forms has been completed, all debris has been removed, all Materials to be embedded in the concrete have been placed for the unit to be cast, and the forms and Materials have been inspected.

N. When removing supports, avoid overstressing the concrete or damaging its surface, and allow the Structure to uniformly and gradually take the stresses resulting from its own mass. After placing concrete, maintain Falsework or forms as required in Table 610.03-2, exclusive of Days when the temperature is below 40 degrees Fahrenheit.

O. Alternatively, if, after 7 Days following concrete placement, the concrete attains the specified compressive strength, remove forms or Falsework. Release Falsework supporting any span of a continuous or rigid frame Bridge only after the structural concrete in the entire span attains the specified compressive strength.

P. Release Falsework before placing the railings, copings, or barriers for all types of Bridges.

Q. Release Falsework for post-tensioned portions of Structures after the prestressing steel has been tensioned.

R. Remove all forms and Falsework except for the following:

1. Portions of driven Falsework piles that are more than 12 inches below subgrade within roadbeds, or 24 inches below the original ground or finished grade outside of roadbeds, or 24 inches below the established limits of any navigation channel;

2. Footing forms if their removal would endanger the safety of cofferdams or other Work;

3. Forms from enclosed cells where access is not provided;

4. Deck forms in the cells of box girder Bridges that do not interfere with the future installation of utilities shown in the Contract Documents.

604.03.3 Jacking Bridge

A. Construct jacks in accordance with the approved jacking support Plan.

B. Ensure jacks used for jacking operations have the rate capacity shown clearly on the manufacturer's name plate attached to each jack.

C. Use the shielded metal-arc process for all field welding. Follow all requirements of the Specifications for welding except that the requirements for radiographic and ultrasonic inspection will be waived if a visual inspection by the Engineer indicates the welds are satisfactory.

D. Thoroughly clean areas under the jacks to provide a flat, clean jacking surface.

E. Ensure the use of the correct scheme and jack capacity as shown in the Contract Documents. Repair any damage resulting from the misuse of the jacking scheme to any portion of the existing Structure that is to remain in place. Repair shall be in accordance with Section 628.

F. Adhere to the following requirements and restrictions during the jacking sequences:

1. The Engineer or his representative shall be present during all jacking operations and shall check all pertinent dimensions and requirements, as set forth in the Contract Documents and herein, to ensure that all pertinent stipulations are met before commencement of the actual jacking.

2. Jacks with a higher capacity than those listed in the Contract Documents may be allowed, but the Contractor shall be responsible for monitoring the jack load to ensure the safety of the Structure.

3. The jack system shall be equipped with a gage to directly read the jack force in pounds or kips or shall be accompanied by a chart with which the dial reading can be converted into pounds. Direct-reading gages are preferred.

4. Do not exceed the maximum jacking forces shown in the Contract Documents.

5. The jack hydraulics may not be used to support the load after jacking. All loads must be transferred to the jacking supports after jacking.

G. Repair areas in accordance with Section 628 if damaged during removal of jacking supports.

604.03.4 Protective Shield

A. In order to protect vehicular traffic against damage from falling Material, debris, and other demolition operations while the superstructure is being removed, furnish and erect a protective shield under the Work area and 5 feet minimum beyond all sides of full depth concrete deck removed, unless other provisions are provided.

B. Ensure the protective shield meets the following:

1. Supplement the shields with such additional suitable enclosures of tarpaulins or wire mesh, as may be necessary, to ensure against the dropping of Materials, tools, Equipment, and other objects below the level of the shield.
2. Remove broken concrete and other debris promptly such that it does not accumulate on the shield.
3. Do not use the shield for storing or stockpiling construction Materials.
4. Assemble the shield by means of bolts and nails as approved by the Engineer.
5. The flooring and siding of the shield shall have no cracks or openings through which Material particles may fall.
6. Install all connections of the protective Structures to the steel work of existing Bridge by means of clamps or other approved devices. The drilling of holes in the existing steel work, or welding thereto, will not be permitted.
7. Remove and dispose of protective shield after it has served its purpose and approval has been given by the Engineer.

604.03.5 Cofferdams

A. Provide a cofferdam with sufficient depth and materials to obtain, as nearly as possible, a watertight seal and with ample clearance to allow sump areas and inspection of the forms for the finished Structure.

B. Do not brace forms for concrete against the cofferdam unless approved by the Engineer.

C. Construct cofferdams to protect new concrete against damage from flooding.

D. Dewater cofferdam in a manner that prevents the loss of concrete Materials.

E. Unless otherwise approved, remove cofferdams and cribs, including all sheeting and bracing, after the completion of the substructure. Take care to avoid disturbing or damaging the finished Structure during removal operations.

604.03.6 Shoring

A. Furnish rigid and strong shoring to safely support the imposed loads and allow for the excavation as required in the Contract Documents.

B. Construct shoring in accordance with the approved Working Drawings. Do not brace forms for concrete against the shoring unless approved by the Engineer.

C. Remove shoring when no longer needed unless otherwise approved or directed by the Engineer to leave in place.

604.03.7 Wetland Access

A. Where shown in the Contract Documents, construct and maintain Stabilized Construction Entrances (SCE).

B. Clear only the trees directly in conflict with the needed access. Flag these trees prior to beginning the clearing operation and obtain concurrence from the Engineer. During tree removal, do not enter wetlands with earthmoving Equipment. Remove all felled trees by use of winch or other similar equipment. Cut trees as close to the existing ground as possible. No stump removal will be necessary. Do not grub in wetland areas.

C. Install geotextile fabric on existing ground.

D. Install stone to provide stable surface. Ensure stone does not extend beyond the edges of the geotextile fabric. The thickness and type of stone will be at the discretion of the Contractor and must be capable of supporting the anticipated Equipment.

E. Install timber mats if necessary to support proposed Equipment.

F. After the Stabilized Construction Entrances are no longer needed, carefully remove and dispose of all materials including geotextile fabric.

G. Restore disturbed wetland areas to their preconstruction condition.

604.04 Method of Measurement.

The quantity of temporary works will not be measured.

604.05 Basis of Payment.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
604000	JACKING BRIDGE	LS
604001	PROTECTIVE SHIELD	LS
604002	COFFERDAMS	LS
604003	SHORING	LS
604004	WETLAND ACCESS	LS

The cost of Falsework is incidental to the Item requiring the use of Falsework.

The cost of Formwork, including form liners, is incidental to the concrete Item being constructed.

Price and payment for jacking Bridge constitutes full compensation for required submittals; for furnishing all labor and Materials including tools, Equipment, jacking supports, hydraulic jacks, any temporary blocking or shims, all labor and any additional Materials required to jack existing Bridge as specified herein, as shown in the Contract Documents, or as directed by the Engineer. Damages caused by construction and removal of jacking supports will be repaired at no cost to the Department.

Price and payment for protective shield constitutes full compensation for furnishing all Materials and performing the Work as detailed and noted in the Contract Documents, for removal and disposal of the protective shield materials, and for all submittals, labor, tools, Equipment, and incidentals necessary to complete the Work.

Price and payment for cofferdams constitutes full compensation for furnishing all Materials and performing the Work as detailed and noted in the Contract Documents, for removal and disposal of the cofferdam materials, and for all submittals, labor, tools, Equipment, and incidentals necessary to complete the Work. If directed to leave cofferdams or parts of the cofferdams in place, the actual cost of the Materials left in place will be paid.

Price and payment for shoring constitutes full compensation for furnishing all Materials and performing the Work as detailed and noted in the Contract Documents, for removal and disposal of the shoring materials, and for all submittals, labor, tools, Equipment, and incidentals necessary to complete the Work. If directed to leave shoring or parts of the shoring system in place, the actual cost of the Materials left in place will be paid.

Price and payment for wetland access constitutes full compensation for furnishing all Materials, placement, removal, and grading necessary for installation of the wetland access as detailed and noted in the Contract Documents, for removal and disposal of the wetland access Materials, for restoring the wetland access area to preconstruction conditions, and for all submittals, labor, tools, Equipment, and incidentals necessary to complete the Work. Clearing and Grubbing, seeding, and Stabilized Construction Entrances will be paid for under the respective pay Items.

SECTION 605 - DRIVEN PILES

605.01 Description.

Furnish and install foundation piles of the type and dimensions designated, including cutting off or building up foundation piles when required.

605.02 Materials.

Provide Materials as specified in:

Timber Piles	Section 1032
Cast-in-Place Concrete Piles (Steel Shell Piles)	Section 1032
Reinforcing Steel	Section 611 and Section 1037
Portland Cement Concrete, Class A	Section 1022
Prestressed Concrete Piles	Section 1032
Steel H Piles	Section 1032

Note: When test piles are required, furnish test piles according to the test pile length listed in the Contract Documents. When test piles are required, the production pile lengths shown are estimated lengths only. The actual lengths to be furnished for production piles will be determined by the Engineer after the test piles have been driven. This applies for all pile types.

605.03 Construction.

605.03.1 Storage and Handling. Lifting, storage, transporting, erecting, and bracing of piles is the sole responsibility of the Contractor.

A. Avoid damage to the piles by properly protecting and handling piles during storage. Use only slings or other appropriate rigging at the designated pick-up points to avoid damage to the piles.

B. Prior to shipping and handling the piles, submit Working Drawings to the Engineer for review, showing the procedures for picking up, transporting, and handling the piles. Submit a repair method for damaged piles, to the Engineer for review. Rejected piles will be replaced at no cost to the Department. Piles with the following conditions are considered defective and will be rejected:

1. A concrete pile is considered defective if a visible crack appears around the entire periphery of the pile, or any other crack or defect is observed that is determined to affect the strength or performance of the pile**.**
2. A steel pile is considered defective if it is bent, kinked, or distorted.
3. A timber pile is considered defective if the treatment is damaged or the integrity of the pile is compromised.

605.03.2 Pile Installation Equipment. Submit, for approval by the Engineer, information regarding the proposed pile driving system on the form, "Pile and Pile Driving Equipment Data" (see Figure 605.03C-1 below).

A. *Pile Hammers.* Provide to the Engineer the technical specifications and operating instructions related to hammer Equipment. Piles may be driven with air, steam, diesel, or hydraulic hammers.

1. *Air and Steam Hammers.* Use a plant and Equipment having sufficient resistance to maintain, under working conditions, the volume and pressure specified by the manufacturer. Equip the plant and Equipment with accurate pressure gauges that are easily accessible to the Engineer. Ensure that the weight of the striking parts of air and steam hammers are at least one-third the weight of the helmet and pile being driven, but in no case less than 2,750 pounds.
2. *Diesel Hammers*. Equip open-end (single-acting) diesel hammers with a device such as rings on the ram to allow the Engineer to visually determine hammer stroke at all times during pile driving

operations. Also, provide the Engineer with a chart from the hammer manufacturer equating stroke and blows per minute for the open-end diesel hammer that will be used.

3. *Hydraulic Hammers.* Use a power plant having sufficient resistance to maintain, under working conditions, the volume and pressure specified by the manufacturer. Equip the power plant and Equipment with accurate pressure gauges that are easily accessible to the Engineer.

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Figure 605.03C-1- Department's Pile and Driving Equipment Data Form.

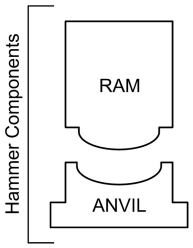
Delaware Department of Transportation — Pile and Driving Equipment Data Form

Contract No.:	Structure Name and/or No.:
Project Name (Section):	
Project Manager	Contractor
County:	Pile Driving or Subcontractor (Piles driven by):

TYPE OF LEADS: ☐ Fixed ☐ Semi-Fixed ☐ Swinging

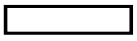
OTHER (Provide Description) _____

LEAD DIMENSIONS Depth _____ Width _____



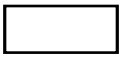
HAMMER

MANUFACTURER	MODEL	TYPE
SERIAL NO.	OWNER:	
RATED ENERGY kip-ft (kN-m)	@ LENGTH OF STROKE ft (m)	RAM WT. lb (kg)
RANGE IN OPERATING ENERGY TO kip-ft (kN-m)	RANGE IN OPERATING STROKE TO kip-ft (kN-m)	
MODIFICATIONS		



STRIKER PLATE

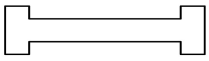
MATERIAL	THICKNESS in (mm)	AREA in² (mm²)



HAMMER CUSHION

MATERIAL #1	MATERIAL #2 (FOR COMPOSITE CUSHION)
AREA in² (mm²)	AREA in² (mm²)
THICKNESS/PLATE in (mm)	THICKNESS/PLATE in (mm)
NO. OF PLATES	NO. OF PLATES

TOTAL THICKNESS OF HAMMER CUSHION in² (mm²)
MODULUS OF ELASTICITY - E ksi (MPa)
COEFFICIENT OF RESTITUTION - e COR

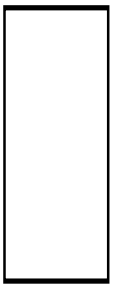


HELMET (DRIVE HEAD)

WEIGHT lb (kg)	MODIFICATIONS

PILE CUSHION

MATERIALS		AREA in² (mm²)
NO. OF SHEETS	THICKNESS/SHEET	TOTAL THICKNESS
MODULUS OF ELASTICITY - E ksi (MPa)	COEFFICIENT OF RESTITUTION - E COR	



PILE

PILE TYPE	WEIGHT/METER lb/yd (kg/m)
WALL THICKNESS in (mm)	TAPER in/ft (mm/m)
ORDERED LENGTH ft (m)	CROSS SECTIONAL AREA in² (mm²)
BEARING RESISTANCE REQUIRED kips (kN)	
DESCRIPTION OF SPLICE	
DRIVING SHOE/CLOSURE PLATE DESCRIPTION	

SUBMITTED BY	DATE
TELEPHONE NO.	EMAIL ADDRESS

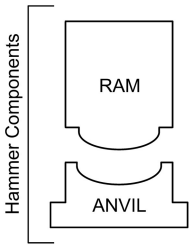
Delaware Department of Transportation — Pile and Driving Equipment Data Form

Contract No.:	Structure Name and/or No.:
Project Name (Section):	
Project Manager	Contractor
County:	Pile Driving or Subcontractor (Piles driven by):

TYPE OF LEADS: ☐ Fixed ☐ Semi-Fixed ☐ Swinging

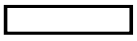
OTHER (Provide Description) _____

LEAD DIMENSIONS Depth _____ Width _____



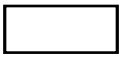
HAMMER

MANUFACTURER	MODEL	TYPE
SERIAL NO.	OWNER:	
RATED ENERGY kip-ft (kN-m)	@ LENGTH OF STROKE ft (m)	RAM WT. lb (kg)
RANGE IN OPERATING ENERGY TO kip-ft (kN-m)	RANGE IN OPERATING STROKE TO kip-ft (kN-m)	
MODIFICATIONS		



STRIKER PLATE

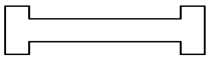
MATERIAL	THICKNESS in (mm)	AREA in² (mm²)



HAMMER CUSHION

MATERIAL #1	MATERIAL #2 (FOR COMPOSITE CUSHION)
AREA in² (mm²)	AREA in² (mm²)
THICKNESS/PLATE in (mm)	THICKNESS/PLATE in (mm)
NO. OF PLATES	NO. OF PLATES

TOTAL THICKNESS OF HAMMER CUSHION in² (mm²)
MODULUS OF ELASTICITY - E ksi (MPa)
COEFFICIENT OF RESTITUTION - e COR

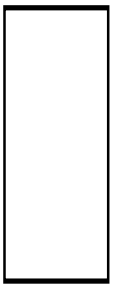


HELMET (DRIVE HEAD)

WEIGHT lb (kg)	MODIFICATIONS

PILE CUSHION

MATERIALS		AREA in² (mm²)
NO. OF SHEETS	THICKNESS/SHEET	TOTAL THICKNESS
MODULUS OF ELASTICITY - E ksi (MPa)	COEFFICIENT OF RESTITUTION - E COR	



PILE

PILE TYPE	WEIGHT/METER lb/yd (kg/m)
WALL THICKNESS in (mm)	TAPER in/ft (mm/m)
ORDERED LENGTH ft (m)	CROSS SECTIONAL AREA in² (mm²)
BEARING RESISTANCE REQUIRED kips (kN)	
DESCRIPTION OF SPLICE	
DRIVING SHOE/CLOSURE PLATE DESCRIPTION	

SUBMITTED BY	DATE
TELEPHONE NO.	EMAIL ADDRESS

B. *Wave Equation Analysis Submittals*. Thirty (30) Days prior to driving piles, submit the wave equation analysis, pile, and pile driving Equipment information using the Department's Pile and Driving Equipment Data Form.

1. Submit a wave equation analysis demonstrating the suitability of each type of pile and each proposed pile driving system. Each analysis is required to be signed and sealed by a Professional Engineer registered in the State of Delaware.

2. Ensure the static soil analysis is included with and in the wave equation analysis.

3. Submit the qualifications of the selected pile testing firm for dynamic testing for approval at the time of the wave equation analysis submittal. Approval will be based on qualifications and applicable previous experience on other projects.

C. Wave Equation Analysis Requirements

1. Use the wave equation analysis 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 resistance and tip elevation. These criteria may be reevaluated during test pile driving and may or may not be revised for production pile driving.

   Include computer input and output sheets and suitable data plots displaying the wave equation analysis for the pile driving throughout the various subsurface conditions of the site. Show resistance versus blow count as well as maximum tension and compression stresses versus resistance on the plots.

   Perform a wave equation analysis for each test and indicator pile unless otherwise specified in the Contract Documents. Evaluate drivability of the pile to various depths of penetration using the proposed driving system. Evaluate the driving conditions for 5 percent penetration, 70 percent penetration, 90 percent penetration, 100 percent penetration, and 110 percent penetration of the pile during initial driving and after set-up condition as a minimum. Perform additional analysis at depths where difficult driving or significant changes in drivability are anticipated. One hundred percent penetration refers to penetration to the plan estimated tip elevation to achieve the designated ultimate resistance. Use the wave equation analysis estimate of tip elevation for the ultimate resistance if it differs from the Plan estimate by more than 10 percent at 100 percent penetration. Show the driving conditions for Plan estimated depth in the analysis if the wave equation analysis estimate is chosen as 100 percent penetration.

   Use the estimated friction and end bearing values obtained by the static soil analysis along with soil layer specific quake and damping values and friction parameters for each level of penetration in the drivability analysis. As a minimum, include ultimate resistances, blow counts, compressive and tensile stresses, and transferred energy plotted as a function of depth of penetration in the analysis output. Submit the static soil analysis with the wave equation analysis.

   If the driving Equipment consists of a varying energy or varying stroke type hammer, such as an open-ended diesel hammer, perform an additional analysis that plots blow count versus stroke and/or energy for a fixed resistance equal to the ultimate resistance (bearing graph).

   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 inches. Driving resistance cannot exceed 20 blows per 1 inch in the last 6 inches of penetration.

   In addition, the Engineer will use the following criteria in evaluating wave equation results to determine the acceptability of the Contractor's proposed driving system.

   a. For steel piles, the maximum permissible compressive or tensile driving stress is 90 percent of the minimum yield strength of the pile material.

   b. For prestressed concrete piles in normal environments, the maximum permissible tensile stress is 3 multiplied by the square root of the concrete compressive strength, f_c', plus the effective prestress value, f_{pe}, or $3\sqrt{f_c'} + f_{pe}$, with all units expressed in pounds per square inch.

c. The maximum permissible compressive stress for prestressed concrete piles is 85 percent of the compressive strength minus the effective prestress value, or 0.85 $f_c{}' - f_{pe}$. In severe corrosive environments, the maximum permissible tensile stress for prestressed concrete piles is f_{pe}.

d. For timber piles, the maximum permissible compressive driving stress is three times the permissible static design strength listed in the Contract Documents.

The Engineer will complete the conformance review and comment on the driving system within 14 Days of receiving the Contractor's Pile and Driving Equipment Data Form and Modify or replace the proposed methods or Equipment for nonconforming analysis at no cost to the Department. The Engineer will complete the conformance review of the revised driving system within 7 Days of receipt of a revised Pile and Driving Equipment Data Form and wave equation analysis.

Do not modify the driving system without the Engineer's written approval. The Engineer will only consider changes to the driving system after the Contractor has submitted the necessary information and a revised wave equation analysis for conformance review.

D. *Drive System Components and Accessories*:

1. *Hammer Cushion*. Equip impact pile driving Equipment, designed to be used with a hammer cushion, with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to ensure uniform driving behavior. Furnish hammer cushions made of durable manufactured materials, provided in accordance with the hammer manufacturer's guidelines. Do not use wood, wire rope, and asbestos hammer cushions. Place a striker plate, as recommended by the hammer manufacturer, on the hammer cushion to ensure uniform compression of the cushion material. Remove the hammer cushion from the helmet and inspect in the presence of the Engineer when beginning pile driving at each Structure or after each 100 hours of pile driving, whichever is less. Replace hammer cushions compressed to less than 75 percent of the original thickness before resuming pile driving.

   a. *Helmet*. Piles driven with impact hammers require an adequate helmet or drive head to distribute the hammer blow to the pile head. Align the helmet axially with the hammer and the pile. Use leads to guide the helmet and prevent it from swinging freely. Fit the helmet around the pile head in a manner that prevents transfer of torsional forces during driving, while maintaining proper alignment of hammer and pile.

   For steel and timber piling, cut the pile heads so that they are square, and provide a helmet, as recommended by the hammer manufacturer, to hold the axis of the pile in line with the axis of the hammer.

   For precast concrete and prestressed concrete piles, cut the pile head to a true plane perpendicular to the longitudinal axis of the pile to prevent eccentric impacts from the helmet.

   For special types of piles, provide appropriate helmets, mandrels, or other devices according to the manufacturer's recommendations to prevent damage to the piles during driving operations.

2. *Pile Cushion*. Protect the heads of concrete piles with a pile cushion made of plywood, hardwood, or composite plywood and hardwood materials. Prior to driving, place on the pile head a pile cushion with a minimum thickness of 6 inches. Provide a new pile cushion for each pile. In addition, replace the pile cushion if, during the driving of any pile, the cushion is compressed more than one-half the original thickness or it begins to burn. Ensure the pile cushion dimensions match the cross-sectional area of the pile top. The Engineer will evaluate the use of manufactured pile cushion materials in lieu of a wood pile cushion on a case-by-case basis.

3. *Leads*. Use leads to support piles in line and position while being driven. Construct pile driver leads to allow the hammer to move freely while maintaining the alignment with the pile to ensure concentric impact for each blow. The Contractor may either use fixed- or swinging-type leads. When using swinging-type leads, fit a pile gate at the bottom of the leads and, in the case of battered piles, fit a horizontal brace between the crane and the leads, as necessary. Ensure that the pile section being driven does not extend above the leads. Adequately embed the leads in the ground or constrain the pile

in a structural frame such as a template to maintain alignment. Provide leads of sufficient length to make the use of a follower unnecessary, and designed to allow proper alignment of battered piles.

4. *Followers*. Only use followers when approved in writing by the Engineer, or when specifically stated in the Contract Documents. In cases where a follower is allowed, drive the first pile in each bent, and every tenth pile driven thereafter, full-length without a follower, to determine that adequate pile penetration is being attained to develop the ultimate pile resistance.

   Hold and maintain the follower and pile in equal and proper alignment during driving. Use a follower of the material and dimensions that will allow the piles to be driven to the penetration depth determined necessary from the driving of the full-length piles. Verify the final position and alignment of the first two piles installed with followers in each substructure unit according to the location tolerances specified in Section 605.03.5.B. before installing additional piles.

5. *Jets*. Only perform jetting if approved in writing by the Engineer or when specifically stated in the Contract Documents. Water jets will not be permitted when installing any steel H piles. When jetting is not required in the Contract Documents, but approved after the Contractor's request, determine the number of jets and the volume and pressure of water at the jet nozzles necessary to freely erode the material adjacent to the pile without affecting the lateral stability of the final in-place pile. Assume responsibility for damage to the site caused by unapproved or improper jetting operations. When jetting is specifically required in the Contract Documents, provide a jetting plant having sufficient capacity to deliver at all times a pressure equivalent to at least 100 pounds per square inch at two 3/4-inch jet nozzles. In either case, unless otherwise directed by the Engineer, remove jet pipes when the pile toe is a minimum of 5 feet above the prescribed toe elevation, and drive the pile to the required ultimate pile resistance with a pile hammer. Also, control, perform any necessary treatment, and dispose of jet water in a manner satisfactory to the Engineer.

E. *Augering*. When stated in the Contract Documents, auger holes at pile locations to the depths shown on the Plans. Auger holes of a size smaller than the diameter or diagonal of the pile cross section that is sufficient to allow penetration of the pile to the specified depth. If subsurface obstructions, such as boulders or rock layers, are encountered, the Contractor may increase the hole diameter to the least dimension adequate for pile installation. Maintain augered holes open using bentonite slurry, casing, or an equivalent method both before and during pile driving operations. Fill the void space remaining around the pile after completion of driving with sand or other approved Material. Do not use spuds, a short, strong driven member that is removed to make a hole for inserting a pile, in lieu of augering.

605.03.3 Compression Load Tests:

A. *Static Load Tests*. When required in the Contract Documents or when directed by the Engineer, determine safe bearing resistances of piles by actual load tests. Satisfy all requirements in accordance with the Notes indicated in the Contract Documents.

B. *Dynamic Load Tests*.

1. *Materials and Construction Methods.* Provide Equipment and perform testing and reporting procedures in strict accordance with ASTM D 4945 - *Standard Test Method for High-Strain Dynamic Testing of Piles*.

   Employ a pile testing firm experienced in high-strain dynamic monitoring of driven piles to conduct the load tests in compliance with these Specifications, to record all data, and to furnish reports of the test results to the Engineer except when the Contract Documents show that the Department will provide these services. The pile testing firm is required to have at least five (5) years of documented experience in the performance and interpretation of dynamic pile testing. The testing firm's field engineer or technician operating the instrumentation and collecting the data is required to have documented experience on at least ten (10) prior projects with similar pile requirements. The field engineer or technician responsible for operating the instrumentation must be fully capable of understanding and interpreting the data being collected during driving and must possess a valid Certificate of Proficiency issued by the Pile Driving Contractors Association (PDCA).

Provide the Engineer with reasonable inspection access along the full length and perimeter of all piles prepared for instrumentation attachment prior to the piles being lifted and located in the leads.

Do not install the dynamic monitoring instrumentation on the pile, including all gauges and cables, until the pile has been lifted and aligned in the leads and the hammer and helmet have been properly set.

Provide sufficient length of indicator and test piles for uninterrupted driving during dynamic testing.

Perform dynamic testing during the entire initial drive and re-strike of all indicator piles so designated in the Contract Documents or as otherwise directed by the Engineer. Continuously monitor the tensile and compressive stresses during driving to ensure that the permissible stress limits provided by the Engineer are not exceeded during driving. Immediately reduce the hammer stroke or stop the driving operation if stresses in the pile approach or exceed the permissible limits in order to prevent pile damage. If non-axial driving is indicated by dynamic test measurements, stop pile driving immediately and realign the driving system or take other corrective action, as necessary, before resuming driving.

If the top of pile is damaged or becomes deformed at any time during the dynamic testing of the piles, stop pile driving and cut off the damaged area in accordance with Section 605.03.8. Properly prepare the remaining pile section for gauge installation and once the pile has been inspected and approved by the Department, continue driving.

Drive all dynamically tested piles to an adequate depth to achieve the minimum tip elevation and the minimum initial driving resistance specified by the Engineer. If field data indicates the hammer system is not transferring to the pile the full energy anticipated at the end of initial drive, increase the hammer stroke and/or driving resistance until the minimum initial drive resistance is displayed on the dynamic testing apparatus. Do not exceed the permissible stress limits.

Maintain a minimum distance of 1 foot between the pile monitoring gauges and the ground surface, water surface, or pile template. If additional ground penetration is required, stop driving the pile, remove the gauges and splice the pile before proceeding with additional driving and monitoring. Prior to splicing, properly prepare the pile splice segment for gauge installation in accordance with ASTM D 4945 and make it accessible to the Engineer for inspection. After the pile has been properly spliced and the hammer and leads have been reset, reattach the gauges to the new pile segment and continue the drive.

Dynamically test all re-strikes of indicator and test piles and of certain production piles selected by the Engineer. Follow the procedures in Section 605.03.6. for all re-strikes.

If for any reason, any component of the pile driving system does not function properly during the pile re-strike, wait up to five (5) Days and perform additional re-strikes until the pile driving system operates properly through a complete continuous re-strike procedure at no additional cost to the Department.

2. *Reporting.* Prepare and submit, within three (3) Working Days of the completion of each dynamic test, a written report with the results of the test pile program including the following:

a. Meet the requirements of ASTM D 4945;

b. specifics of the pile resistance observed during dynamic testing;

c. performance of the hammer and driving system;

d. driving stress levels;

e. integrity of the pile.

   i. Provide the following data in the report for the full length of driving at intervals of not more than 10 hammer blows:

f. bearing resistance from the Case Method and one additional recognized method;

g. input and reflection values of force and velocity;

h. maximum transferred energy;

i. maximum compressive stress;

j. maximum tensile stress;

k. blows per minute;

l. values of upward and downward traveling force wave;

m. ram stroke;

n. pile penetration depth and corresponding blow sequence;

o. detailed results of the CAPWAP analyses;

p. all extrema tables;

q. pile profile and pile model tables;

r. simulated load test curves for the tip and top of the pile;

s. the soil parameters used in the analysis by matching the measured and computed values of forces;

t. velocities and displacements;

u. static resistance distribution along the length of the pile(s);

v. upon request, submit all raw data and computer analyses in electronic format.

Perform a minimum of three (3) CAPWAP analyses for all initial drives and re-strikes of dynamically tested piles:

a. one (1) for a representative blow near the end of each initial drive;

b. two (2) representative blows towards the beginning of the re-strike;

c. Perform one additional CAPWAP analysis per initial drive or re-strike at selected pile penetration depths, at no additional cost to the Department, at the request of the Engineer.

C. *General.* For any test or anchor piling that is not a part of the finished Structure, remove or cut off pile in accordance with Section 605.03.8, if not located within the footing area.

605.03.4 Indicator and Test Piles. Follow the step-by-step procedures listed below when driving indicator and test piles.

A. Perform the wave equation analysis based on the procedure outlined in Section 605.03.2.C.

B. Ensure that indicator and test piles are the initial piles driven and are the same material and dimensions as the production piles. Install indicator and test piles at the locations indicated in the Contract Documents. Do not place bar reinforcement and concrete fill or grout until conclusion of the testing and acceptance of the indicator and test pile for use as a production pile.

C. Furnish the Engineer with schedules of the proposed driving sequence. Do not begin driving of test piles at any location until the schedule for that location has been approved by the Engineer. Do not depart from these schedules without the prior approval of the Engineer.

D. Conduct the test pile driving operations in close cooperation with the Engineer and in a manner such that essential measurements and data can be obtained. The Engineer will be present when the test pile driving Work is in progress. A complete driving log will be recorded by the Engineer for each test pile driven. The driving log will list all data essential for the determination of correct bearing resistance.

E. If one or more static load test is required, perform at least one of the load tests in the first series of test piles driven.

F. Provide lengths of test piles as indicated in the Contract Documents. If the Contractor's static analysis predicts a need for alternate test pile lengths, clearly indicate the lengths of test piles in the wave equation analysis submittal. After evaluating the wave equation analysis, the Engineer will then issue an order length for test piles. Do not order any test piles with an alternate length prior to receiving the confirmation letter from the Engineer confirming test pile order length.

G. Furnish test piles in one length and drive them continuously to the required bearing resistance and/or tip elevation unless otherwise approved by the Engineer.

H. Drive test or indicator pile in accordance with Section 605.03.4.

I. 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 or more of the following requirements:

1. Establish the required blow count, stroke height and minimum tip elevation for the driving of production piles based on satisfactory test or indicator pile results.

2. Issue, within five Working Days after completion of the test pile driving, a list of production pile lengths for those piles governed by the test pile or group of test piles.

3. Order a test pile re-strike to be performed in accordance with Section 605.03.6. within two Working Days after completion of the initial driving.

4. Order a driving splice to be made on the test pile within two Working Days after completion of the initial driving. Make the driving splice in accordance with the driving splice details shown in the Contract Documents. After splicing is successfully completed, continue driving of the spliced pile. 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.

5. Approve the driven test pile for load testing when requiring static load testing.

   Requirements 9.b., 9.c., or 9.d. above may be chosen prior to authorizing a load test to be performed or if a load test is performed and found to be unsatisfactory. The Engineer will issue a list of production pile lengths within two Working Days after receipt of the load test report for those piles governed by the test pile or group of test piles.

6. If the data and information obtained from driving any original test or indicator pile is conflicting, inconclusive, or unsatisfactory in any way, the Engineer will order, within two Working Days after receipt of the load test report, another test pile to be driven for additional information.

J. Construct any build-ups (non-driving splices) in accordance with the requirements of Section 605.03.7.

K. Cut off test piles, as necessary, in accordance with the requirements of Section 605.03.8.

605.03.5 Preparation and Driving of Production Piles*:* When driving production piles, use this step-by-step procedure:

A. Preparation

1. Drive the production piles using the same hammer, cushioning, and other Equipment that was used to drive the indicator and test piles. If the there is a change in hammers, 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.

2. Drive all piles at locations shown in the Contract Documents or as directed by the Engineer. Place individual piles in pile groups either starting from the center of the group and proceeding outwards in both directions, or starting at the outside row and proceeding progressively across the group.

3. Perform the pile driving sequence in conformance with the requirements established under Section 605.03.5.B. If necessary, provide additional detail so that the Engineer is fully aware and in agreement with the proposed sequence of driving.

B. Driving

1. Provide all facilities so that the required records will be kept of the pile lengths, hammer speeds, blows per foot, tip elevations, and other pertinent data for all piles driven. Clearly mark the pile in 12 inch increments visible from a safe inspection distance.

2. Ensure the heads of all piles are in a true plane and perpendicular to the longitudinal axis of the pile before attaching the helmet. Protect the heads of concrete piles with a pile cushion as specified in Section 605.03.2.D.2. Do not apply side pressure for driving piles into the correct position.

3. During pile driving, change the pile cushion as specified in Section 605.03.2.D.2. The Engineer's prior approval of a pile hammer will not relieve the Contractor of responsibility for piles damaged because of misalignment of the leads, failure of cushion materials, failure of splices, malfunctioning of the pile hammer, or other improper construction methods. When the Engineer determines that such damage impairs the strength of the pile, replace the pile at no cost to the Department.

4. Drive each production pile continuously from the time that driving is started until the required bearing resistance and/or tip elevation is reached, except as may be required for splicing the pile.

5. Do not drive the pile to exceed 240 blows per 12 inches or 20 blows per 1 inch of driving for 3 consecutive inches. Immediately inform the Engineer if a pile reaches driving resistances exceeding 240 blows per 12 inch or 20 blows per 1 inch at a tip elevation above the minimum tip elevation specified.

6. Drive piles until they develop the nominal bearing resistance that is specified or until they reach practical refusal. The Engineer reserves the right, however, to establish a minimum tip elevation to which any or all piles are to be driven, depending on the actual conditions encountered.

7. If the top of a pile is damaged or becomes deformed at any time during driving, stop pile driving and cut off the damaged area in accordance with Section 605.03.8.

8. Drive piles within an allowed variation of 1/8 inch per 12 inches of pile length from the vertical or batter shown in the Contract Documents. The maximum allowable variation at the top of the pile is 3 inches in any direction from the location shown in the Contract Documents.

9. Make any driving splices determined necessary by the Engineer in accordance with the Contract Documents or submit other details to the Engineer for review and approval. When the splice is complete, drive the spliced pile to the required bearing resistance and/or tip elevation. If it becomes necessary to splice timber piles, submit the method for splicing and driving to the Engineer for written approval.

10. Remove and replace 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. Remove and replace any driven timber pile that shows evidence of splitting, splintering, or brooming. Remove and replace any driven shell or casing that shows bends, kinks, or other deformations which are detrimental to its use as a production pile. 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.

C. Post-Driving

1. The Engineer may direct the Contractor to re-strike selected production piles. If this direction is given, perform the production pile re-strikes in accordance with the requirements of Section 605.03.6.

2. Survey the location and alignment of the piles after driving of each pile group. Furnish the results of the survey 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 damage or out of tolerance location, remove the rejected pile or drive additional piles as directed by the Engineer. In addition, 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 will be rejected.

3. Check piles for heave during driving of adjacent piles or by any other cause. Re-drive all piles heaved more than 1/4 inch to the nominal bearing resistance and at least to their original tip elevation, or as directed by the Engineer. Remove any material forced up between the piles during driving to the correct elevation before any concrete is placed for the foundation.
4. Construct any build-ups (non-driving splices) in accordance with the requirements of Section 605.03.7.
5. Cut off piles, as necessary, in accordance with the requirements of Section 605.03.8.

605.03.6 Pile Re-strike. After initial driving of production, indicator, and/or test piles, the Engineer may order a pile re-strike within two Working Days after completion of the initial driving. Perform the re-strike within seven Days of initial driving unless otherwise noted in the Contract Documents. Perform the pile re-strike after the directed waiting time has elapsed, as follows:

A. As necessary, connect dynamic pile testing Equipment in accordance with Section 605.03.3.B as indicated in the Contract Documents or directed by the Engineer.

B. Perform all re-strikes using the same pile hammer, helmet, and compressed cushion material used to install the piles during initial driving.

C. Verify proper operation of the driving system by striking another pile or pile cut-off at least 20 blows at full stroke.

D. Establish the elevation of the top of pile using a survey level prior to performing the re-strike.

E. Mark the pile in 1 inch increments for at least 12 inches for measurement of the pile movement during re-strike.

F. Do not use a cold hammer for re-driving. Warm up the hammer before re-driving begins by applying at least 20 blows to another pile.

G. Carefully lower and position the hammer on the pile. Strike the pile 20 blows at the required stroke height.

H. Remove the hammer from the pile and establish the new top of pile elevation using a survey level.

After completion of the pile re-strike, the Engineer will review the driving records and make a recommendation on how to proceed within two Working Days. As directed by the Engineer, up to ten percent of production piles driven with a minimum of ten are subject to pile re-strikes. The Engineer will specify a waiting time of five Days or less to perform the pile re-strikes, unless noted otherwise in the Construction Documents.

The pile or representative group of piles is considered acceptable if the pile re-strike results are satisfactory.

Perform indicator and test pile re-strikes on each pile to be load tested when static load testing is required. The required waiting time is the same as required between the pile re-strike and the pile load test.

605.03.7 Pile Build-Ups. Construct all build-ups as shown in the Contract Documents or submit other details for review and approval by the Engineer.

605.03.8 Pile Cut-Offs.

A. Cut off piles to a true plane to remove damage or deformations detrimental to the performance of the pile driving system or to the integrity of the pile during driving. Allow steel piles to cool after cut off before re-driving.

B. Cut off piles to final cut-off elevation when all pile driving is complete as shown in the Contract Documents or as directed by the Engineer. Cut-off sections of piles are the property of the Contractor. Dispose of cut-offs in accordance with Section 106.08, Disposal of Unacceptable Materials.

1. Cut off pile shells or casings using an acetylene or electric torch.
2. Saw piles that support timber caps or grillage to conform to the plane of the bottom of the superimposed structure:

a. Thoroughly brush coat all exposed sawed surfaces of timber piles with three applications of preservative and cover with a thick layer of hot pitch or gum;

b. Install a metal sheet covering of either zinc or copper that is a minimum of 4 inches greater than the diameter of the pile on top of the thick layer of hot pitch or gum;

c. Bend excess metal down over the sides of the pile, trim neatly, and nail securely;

d. Provide zinc sheet conforming to Section 1039.09 and fasten with 1 inch long galvanized, large-headed nails;

e. Provide copper sheet conforming to Section 1039.09 and fasten with 1 inch long copper nails.

C. Cover the tops of pre-stressed concrete piles or steel shell piles with plastic to prevent dirt and water from entering the pile from the time that pile driving is complete until grout or concrete is placed. Remove any dirt or water from holes/sleeves of pre-stressed concrete piles prior to grouting in bar reinforcement.

D. Cut off test piles driven outside permanent foundation locations, upon satisfactory completion of test driving, at a point at least 24 inches below finished grade or final stream bed elevation.

605.03.9 Placing Bar Reinforcement for Cast-In-Place Concrete Piles. Assemble the longitudinal bar reinforcement and circular ties as a complete unit. Securely fasten the bars and ties together at all bar intersections in accordance with the details shown in the Contract Documents. Place the complete unit in the driven casing or shell and ensure that it is held rigidly in place to prevent displacement during the placing of the concrete.

Submit for review, comment, and conformity a Drawing or Plan showing the proposed method of holding the bar reinforcement in position during the placing of the concrete. Review 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.

605.03.10 Placing Concrete for Cast-In-Place Concrete Piles. Do not place concrete in any pile casing or shell until all driving within the same substructure unit is complete and acceptable. In the event that this limitation cannot be followed, do not drive within the above limits until the placed concrete has set for at least seven Days.

After driving and completing the pile and other parts of the Structure, clean the exposed part of the piling of undue discoloration caused by methods of construction.

Do not deposit concrete in a driven casing or shell until all water, dirt, and debris is completely removed and approved by the Engineer.

Place the concrete for each shell or casing 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.

Place concrete for each shell or casing 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, do not place bar reinforcement 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. At this point, rigidly set the bar reinforcement in the casing, and continue to place the concrete until the cut-off elevation is reached. Concrete must remain plastic throughout the duration of its placement. When bar reinforcement caging or dowels occupy only the upper section of the pile, reinforcement may be secured 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.

Do not disturb piles with freshly placed concrete until 50 percent of the 28-day strength is achieved.

605.04 Method of Measurement.

The Engineer will measure work acceptably completed as specified in Section 109.01 and as follows:

A. *Timber, Steel H, Precast Concrete and Cast-in-Place Pipe (or Shell Concrete) Piles Furnished.* The Engineer will measure the quantity of piles furnished as determined by the Department by the total length of piles in Linear Feet. When extensions of piles are necessary, the extension length authorized in writing by the Engineer will be included in the quantity of piling furnished.

B. *Timber, Steel H, Precast Concrete and Cast-in-Place Pipe (or Shell Concrete) Piles Driven.* The Engineer will measure piles driven by the Linear Feet of piling in place measured below the cutoff elevation.

C. *Dynamic Pile Testing.* The Engineer will measure dynamic pile testing on an Each basis upon receipt of acceptable associated dynamic testing report(s). The Engineer will measure each initial drive and each re-strike dynamically monitored as separate units and measured as a quantity of two (2) Each.

D. *Pile Re-strikes.* The Engineer will measure only pile re-strikes that are additional to those described in Section 605.03.6. on an Each basis. Additional re-strikes may result in more than the minimum allowable number of pile re-strikes or the re-strike waiting times greater than specified above.

E. *Splices for Timber, Steel H and Cast-in-Place Pipe (or Shell Concrete) Piles.* The Engineer will measure the quantity of pile Material used and installed in pile splices of all types of piles as the total number of Linear Feet of Material furnished to the site and as agreed by the Department and driven.

F. *Pile Build-ups and Driving Splices for Precast Concrete Piles.* The Engineer will measure the additional length of pile for the purposes of a pile build-up or driving splice for a Precast, Prestressed Concrete Pile on an equivalent Linear Foot basis.

G. *Items Not Measured or Paid.* The Engineer will exclude from measurement and will not pay for:

1. Production piles and test piles furnished to replace piles that were previously accepted by the Engineer but were subsequently damaged prior to Completion of the Contract;
2. splices to timber, steel, and cast-in-place (or shell concrete) piles;
3. production piles and test piles not accepted, production piles and test piles improperly driven, or production piles and test piles damaged during driving;
4. Falsework piles; for piles used in the construction of temporary wharves, platforms, and Bridges built for the Contractor's use;
5. removal and replacement of rejected piles; or for any other piles not specifically shown on the Plans or listed in the Proposal tabulations;
6. reinforcing steel, excavation, drilling, cleaning of drilled holes, drilling fluids, sealing materials, concrete, and casing, and augering, jetting, or other methods used to facilitate pile driving procedures.

605.05 Basis of Payment.

The Department will pay for accepted quantities at the Contract Unit Prices as follows:

ITEM	DESCRIPTION	UNIT
605000	FURNISH TIMBER PILES - TREATED, 12"	LF
605001	FURNISH TIMBER PILES - TREATED, 14"	LF
605002	FURNISH TIMBER PILES - TREATED, 16"	LF
605010	FURNISH CAST-IN-PLACE CONCRETE PILES, 12"	LF
605011	FURNISH CAST-IN-PLACE CONCRETE PILES, 14"	LF
605012	FURNISH CAST-IN-PLACE CONCRETE PILES, 16"	LF
605013	FURNISH CAST-IN-PLACE CONCRETE PILES, 18"	LF
605020	FURNISH STEEL H PILES, HP 10 X 42	LF
605021	FURNISH STEEL H PILES, HP 12 X 53	LF
605022	FURNISH STEEL H PILES, HP 12 X 63	LF
605023	FURNISH STEEL H PILES, HP 12 X 74	LF
605024	FURNISH STEEL H PILES, HP 14 X 73	LF

605025	FURNISH STEEL H PILES, HP 14X 89	LF
605026	FURNISH STEEL H PILES, HP 14X 102	LF
605030	FURNISH STEEL PIPE PILES, 24"	LF
605031	FURNISH STEEL PIPE PILES, 30"	LF
605032	FURNISH STEEL PIPE PILES, 36"	LF
605040	FURNISH PRECAST PRESTRESSED CONCRETE PILES, 12" X 12"	LF
605041	FURNISH PRECAST PRESTRESSED CONCRETE PILES, 14" X 14"	LF
605042	FURNISH PRECAST PRESTRESSED CONCRETE PILES, 16" X 16"	LF
605043	FURNISH PRECAST PRESTRESSED CONCRETE PILES, 18" X 18"	LF
605044	FURNISH PRECAST PRESTRESSED CONCRETE PILES, 20" X 20"	LF
605045	FURNISH PRECAST PRESTRESSED CONCRETE PILES, 24" X 24"	LF
605050	FURNISH TIMBER INDICATOR OR TEST PILES - TREATED, 12"	LF
605051	FURNISH TIMBER INDICATOR OR TEST PILES - TREATED, 14"	LF
605052	FURNISH TIMBER INDICATOR OR TEST PILES - TREATED, 16"	LF
605060	FURNISH CAST-IN-PLACE CONCRETE INDICATOR OR TEST PILES, 12"	LF
605061	FURNISH CAST-IN-PLACE CONCRETE INDICATOR OR TEST PILES, 14"	LF
605062	FURNISH CAST-IN-PLACE CONCRETE INDICATOR OR TEST PILES, 16"	LF
605063	FURNISH CAST-IN-PLACE CONCRETE INDICATOR OR TEST PILES, 18"	LF
605070	FURNISH STEEL H INDICATOR OR TEST PILES, HP 10 X 42	LF
605071	FURNISH STEEL H INDICATOR OR TEST PILES, HP 12 X 53	LF
605072	FURNISH STEEL H INDICATOR OR TEST PILES, HP 12 X 63	LF
605073	FURNISH STEEL H INDICATOR OR TEST PILES, HP 12 X 74	LF
605074	FURNISH STEEL H INDICATOR OR TEST PILES, HP 14 X 73	LF
605075	FURNISH STEEL H INDICATOR OR TEST PILES, HP 14 X 89	LF
605076	FURNISH STEEL H INDICATOR OR TEST PILES, HP 14 X 102	LF
605080	FURNISH STEEL PIPE INDICATOR OR TEST PILES, 24"	LF
605081	FURNISH STEEL PIPE INDICATOR OR TEST PILES, 30"	LF
605082	FURNISH STEEL PIPE INDICATOR OR TEST PILES, 36"	LF
605090	FURNISH PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 12" X 12"	LF
605091	FURNISH PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 14" X 14"	LF
605092	FURNISH PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 16" X 16"	LF
605093	FURNISH PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 18" X 18"	LF
605094	FURNISH PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 20" X 20"	LF

605095	FURNISH PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 24" X 24"	LF
605100	INSTALL TIMBER PILES - TREATED, 12"	LF
605101	INSTALL TIMBER PILES - TREATED, 14"	LF
605102	INSTALL TIMBER PILES - TREATED, 16"	LF
605110	INSTALL CAST-IN-PLACE CONCRETE PILES, 12"	LF
605111	INSTALL CAST-IN-PLACE CONCRETE PILES, 14"	LF
605112	INSTALL CAST-IN-PLACE CONCRETE PILES, 16"	LF
605113	INSTALL CAST-IN-PLACE CONCRETE PILES, 18"	LF
605120	INSTALL STEEL H PILES, HP 10 X 42	LF
605121	INSTALL STEEL H PILES, HP 12 X 53	LF
605122	INSTALL STEEL H PILES, HP 12 X 63	LF
605123	INSTALL STEEL H PILES, HP 12 X 74	LF
605124	INSTALL STEEL H PILES, HP 14 X 73	LF
605125	INSTALL STEEL H PILES, HP 14 X 89	LF
605126	INSTALL STEEL H PILES, HP 14 X 102	LF
605130	INSTALL STEEL PIPE PILES, 24"	LF
605131	INSTALL STEEL PIPE PILES, 30"	LF
605132	INSTALL STEEL PIPE PILES, 36"	LF
605140	INSTALL PRECAST PRESTRESSED CONCRETE PILES, 12" X 12"	LF
605141	INSTALL PRECAST PRESTRESSED CONCRETE PILES, 14" X 14"	LF
605142	INSTALL PRECAST PRESTRESSED CONCRETE PILES, 16" X 16"	LF
605143	INSTALL PRECAST PRESTRESSED CONCRETE PILES, 18" X 18"	LF
605144	INSTALL PRECAST PRESTRESSED CONCRETE PILES, 20" X 20"	LF
605145	INSTALL PRECAST PRESTRESSED CONCRETE PILES, 24" X 24"	LF
605150	INSTALL TIMBER INDICATOR OR TEST PILES - TREATED, 12"	LF
605151	INSTALL TIMBER INDICATOR OR TEST PILES - TREATED, 14"	LF
605152	INSTALL TIMBER INDICATOR OR TEST PILES - TREATED, 16"	LF
605160	INSTALL CAST-IN-PLACE CONCRETE INDICATOR OR TEST PILES, 12"	LF
605161	INSTALL CAST-IN-PLACE CONCRETE INDICATOR OR TEST PILES, 14"	LF
605162	INSTALL CAST-IN-PLACE CONCRETE INDICATOR OR TEST PILES, 16"	LF
605163	INSTALL CAST-IN-PLACE CONCRETE INDICATOR OR TEST PILES, 18"	LF
605170	INSTALL STEEL H INDICATOR OR TEST PILES, HP 10 X 42	LF
605171	INSTALL STEEL H INDICATOR OR TEST PILES, HP 12 X 53	LF
605172	INSTALL STEEL H INDICATOR OR TEST PILES, HP 12 X 63	LF
605173	INSTALL STEEL H INDICATOR OR TEST PILES, HP 12 X 74	LF

605174	INSTALL STEEL H INDICATOR OR TEST PILES, HP 14 X 73	LF
605175	INSTALL STEEL H INDICATOR OR TEST PILES, HP 14 X 89	LF
605176	INSTALL STEEL H INDICATOR OR TEST PILES, HP 14 X 102	LF
605180	INSTALL STEEL PIPE INDICATOR OR TEST PILES, 24"	LF
605181	INSTALL STEEL PIPE INDICATOR OR TEST PILES, 30"	LF
605182	INSTALL STEEL PIPE INDICATOR OR TEST PILES, 36"	LF
605190	INSTALL PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 12" X 12"	LF
605191	INSTALL PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 14" X 14"	LF
605192	INSTALL PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 16" X 16"	LF
605193	INSTALL PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 18" X 18"	LF
605194	INSTALL PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 20" X 20"	LF
605195	INSTALL PRECAST PRESTRESSED CONCRETE INDICATOR OR TEST PILES, 24" X 24"	LF
605200	PILE RESTRIKE	EACH
605201	DYNAMIC PILE TESTING BY CONTRACTOR	EACH

A. *Basis of Payment for Timber, Steel, Precast Concrete and Cast-in-Place Pipe (or Shell Concrete) Piles Furnished.* The Department will pay for the quantity of timber, cast-in-place concrete, steel, and precast, pre-stressed concrete test piles and production piles at the Contract Unit Price per Linear Foot for each type of pile.

Such payment is full compensation for furnishing all pile and test pile Materials, including driving shoe/closure plate (pile reinforcing tip), preservatives for timber piles, metal pile shells, protective coating for piles, bar and spiral reinforcement, pre-stressing 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.

B. *Basis of Payment for Timber, Steel, Precast Concrete and Cast-in-Place Pipe (or Shell Concrete) Piles Driven.* The Department will pay for the installed quantity of timber, cast-in-place concrete, steel, and precast, pre-stressed concrete test piles and production piles at the Contract Unit Price per Linear Foot for each type of pile driven.

Such payment is full compensation for driving and all Work associated with the installation of piles, including augering and jetting, unless noted otherwise, and re-striking production piles and test piles per Section 605.03.6.; 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 is incidental to the installed quantity of piles. Price and payment will constitute full compensation for acceptably performing a pile cut off to the details and elevation shown in the Contract Document; for the disposal of cut-off piles; and for all Equipment, labor, tools, and incidentals required to complete the Work.

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 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.

C. *Basis of Payment for Dynamic Pile Testing.* The Department will pay for the Dynamic Pile Testing authorized and accepted by the Engineer at the Contract Unit Price per Each. Such payment is full compensation for furnishing tools, labor, pile testing firm, Materials, Equipment, analyses, reports, and incidental Work required to perform high-strain dynamic pile testing during initial driving and re-strikes including providing inspection access to the Department.

D. *Pile Re-Strikes.* Payment for additional pile re-strikes authorized by the Engineer will be made at the Contract Unit Price per Each. Price and payment will constitute full compensation for all Work associated with the set up and conducting of the pile re-strikes, and for all Equipment, labor, tools, and incidentals required to complete the Work.

E. *Basis of Payment for Splices for Timber, Steel, and Cast-in-Place Pipe (or Shell Concrete) Piles.* The cost of constructing splices for Timber, Steel, and Cast-in-Place Pipe (or Shell Concrete) Piles will be considered incidental to the Unit Bid Price for "Installation of Piles". The quantity of pile Material used for pile splices will be paid for at the Contract Unit Price per Linear Foot for each type of pile.

F. *Basis of Payment for Pile Build-ups and Driving Splices for Precast Concrete Piles.*

The Department will pay for the quantity of pile build-ups constructed at the Contract Unit Price per Linear Foot for precast, pre-stressed concrete piles, furnished.

Additionally, the Department will pay for each driving splice constructed for Precast, Prestressed Concrete Piles at the equivalent of 10 linear feet of the appropriate Contract Unit Price furnished for the size and type of pile spliced. For example, if a driving splice is required on a production pile and the furnish Unit Bid Price for production piles is $50 per linear foot, then the equivalent length in linear feet, to be added to that particular pile length for payment is 10 L.F. ($50/L.F. * 10 L.F. = $500).

Price and payment is full compensation for all Equipment and labor required to construct a pile build-up or driving splice in accordance with the Contract Documents or details submitted by the Contractor for review and approved by the Engineer.

SECTION 606 – DRILLED SHAFTS

606.01 Description. Furnish all Materials, labor, tools, Equipment, services and incidentals necessary to construct the drilled shafts in accordance with the Contract Documents.

606.02 Materials. Provide Materials as specified in the following:

Steel Casings	Section 1034
Reinforcing Steel	Section 1037
Welding	Section 1039
Portland Cement Concrete, Class A or B	Section 1022
Slurry	Section 1035
Access Tubes for Crosshole Sonic Log Testing	Section 1033
Grout	Section 1047

606.03 Construction.

606.03.1 Submittals, Approvals, and Meetings. At the time of bid, submit the qualifications of the Contractor (i.e., the drilled shaft specialty contractor) to verify the successful completion by the Contractor of at least three separate foundation Projects within the last five years with drilled shafts of similar size (diameter and depth) and similar subsurface geotechnical conditions to those shown in the Contract Documents. Include a brief description of each Project and the owner's contact person's name and current phone number for each project listed.

A. *Experience and Personnel.* At least two weeks prior to the start of drilled shaft construction, submit a list identifying the on-site supervisors and drill rig operators assigned to the Project, to the Engineer for approval. In the list, include a detailed summary of each individual's experience in drilled shaft excavation operations, and placement of assembled reinforcing cages and concrete in drilled shafts.

1. On-site supervisors must have a minimum of two years' experience in supervising construction of drilled shaft foundations of similar size (diameter and depth) and difficulty to those shown in the Contract Documents, and similar geotechnical conditions to those described in the geotechnical report. The work experience must be direct supervisory responsibility for the on-site drilled shaft construction operations. Project management level positions indirectly supervising on-site drilled shaft construction operations are not acceptable for this experience requirement.

2. Drill rig operators must have a minimum one year experience in construction of drilled shaft foundations.

The Engineer will approve or reject the Contractor's qualifications and field personnel within ten Working Days after receipt of the submission. Do not start Work on any drilled shaft until the Contractor's qualifications and field personnel are approved by the Engineer. The Engineer may suspend the drilled shaft construction if the Contractor substitutes field personnel without prior approval by the Engineer. The Contractor is fully liable for the additional costs resulting from the suspension of Work, and no Adjustments in Contract Time resulting from such suspension of Work, will be allowed.

B. *Drilled Shaft Installation Plan*. The Engineer will approve or reject the Contractor's qualifications and field personnel within ten Working Days after receipt of the submission. In preparing the narrative, reference the available subsurface geotechnical data provided in the Contract boring logs and any geotechnical report(s) prepared for this Project. In this narrative, provide at a minimum the following information:

1. Description of overall construction operation sequence and the sequence of drilled shaft construction when in groups or lines.

2. A list, description, and capacities of proposed Equipment, including, but not limited to, cranes, drills, augers, bailing buckets, final cleaning Equipment, and drilling unit. As appropriate, describe why the

Equipment was selected, and describe Equipment suitability to the anticipated site and subsurface conditions. Include a Project history of the drilling Equipment demonstrating the successful use of the Equipment on shafts of equal or greater size in similar subsurface geotechnical conditions.

3. Details of drilled shaft excavation methods, including proposed drilling methods, methods for cleanout of the bottom of the excavation hole, and a disposal plan for excavated material and drilling slurry (if applicable). If appropriate, include a review of method suitability to the anticipated site and subsurface geotechnical conditions including boulders and obstruction removal techniques if such are indicated in the Contract subsurface geotechnical information or Contract Documents.

4. Details of the method(s) to be used to ensure drilled shaft hole stability (i.e., prevention of caving, bottom heave, etc. using temporary casing, slurry, or other means) during excavation and concrete placement. Include a review of method suitability to the anticipated site and subsurface geotechnical conditions.

5. Provide detailed procedures for mixing, using, maintaining, and disposing of the slurry. Also provide a detailed mix design (including all additives and their specific purpose in the slurry mix) and a discussion of its suitability to the anticipated subsurface geotechnical conditions for the proposed slurry.

   In the submittal, include a detailed plan for quality control of the selected slurry, including tests to be performed, test methods to be used, and minimum and/or maximum property requirements that must be met to ensure that the slurry functions as intended, considering the anticipated subsurface conditions and shaft construction methods, in accordance with the slurry manufacturer's recommendations and these Specifications. As a minimum, include the following tests in the slurry quality control plan:

Property	**Test Method**
Density	Mud Weight (Density), API RP 13B-1, Section 1
Viscosity	Marsh Funnel and Cup, API RP 13B-1, Section 2.2
pH	Glass Electrode, pH Meter (ASTM E70), or pH Paper
Sand Content	Sand, API RP 13B-1, Section 5

6. Reinforcing steel Working Drawings, details of reinforcement placement including type and location of all splices, reinforcement cage support and centralization methods, type and location of all spacers, crosshole sonic logging tubes and other instrumentation, and procedures for lifting and setting the reinforcement cage.

7. When casings are proposed or required, provide the following:

   a. Casing dimensions and detailed procedures for permanent casing installation.

   b. Temporary casing installation and removal.

   c. Methods of advancing the casing, along with the means to be utilized for excavating the drilled shaft hole in accordance with Section 606.03.4. of this Specification.

8. When using temporary casing, details of the method to extract the temporary casing and maintaining shaft reinforcement in proper alignment and location, and maintaining the concrete slump to keep concrete workable during casing extraction.

9. Details of concrete placement, including proposed Equipment and procedures for delivering concrete to the drilled shaft, placement of the concrete into the shaft including initial placement and the raising of the tremie or pump line during placement, size of tremie and pump lines, operational procedures for

pumping, and a sample uniform yield form to be used by the Contractor for plotting the volume of concrete placed versus the depth of shaft for all shaft concrete placement. Define time limits for concrete placement with references cited used in determination.

10. The method to be used to form a horizontal construction joint during concrete placement.
11. When applicable, include a description of the Material to be used to temporarily backfill a drilled shaft excavation hole during a stoppage of the excavation operation, as well as the method used to place and remove the Material.
12. Details of procedures to prevent loss of slurry or concrete into waterways, sewers and other areas to be protected.
13. Describe the method and Materials that will be used to fill or eliminate all voids below the top of shaft between the plan shaft diameter and excavated shaft diameter, or between the shaft casing and surrounding soil, if permanent casing is specified.
14. Details of any required load tests including Equipment, instrumentation, procedures, calibration data for test Equipment, calculations, and Drawings.
15. Details and procedures for protecting existing Structures, utilities, roadways, and other facilities during drilled shaft installation.
16. Other information required by the Contract Documents or specified herein.

The Engineer will evaluate the Drilled Shaft Installation Plan for conformance with the Contract Documents within ten Working Days after receipt of the submission. At the option of the Department, a Shaft Installation Plan Submittal Meeting may be scheduled following review of the Contractor's initial submittal of the Plan. Those attending the Shaft Installation Plan Submittal Meeting, if held, must include the following:

a. The Superintendent, on-site supervisors, and other Contractor personnel involved in the preparation and execution of the Drilled Shaft Installation Plan.

b. The Project Engineer and Department's personnel involved with the structural, geotechnical, and construction review of the Drilled Shaft Installation Plan, together with Department's personnel who will provide inspection and oversight during the drilled shaft construction phase of Project.

Submit any significant updates or modifications to the Drilled Shaft Installation Plan whenever such updates or modifications are proposed to the Engineer. The Engineer will evaluate the new information for conformance with the Contract Documents within ten Working Days after receipt of the submission.

C. *Slurry Technical Assistance.* If slurry is used to construct the drilled shafts, provide, or arrange for, technical assistance from the slurry manufacturer as specified in Section 606.03.4.D.1. of this Specification. Submit the following to the Engineer:

1. The name and current phone number of the slurry manufacturer's technical representative assigned to the Project.
2. The name(s) of the Contractor's personnel assigned to the project and trained by the slurry manufacturer's technical representative in the proper use of the slurry. In the submittal, include a signed training certification letter from the slurry manufacturer for each individual, including the date of the training.

D. *Approvals.* Do not begin Work until all the required submittals have been accepted in writing by the Engineer. .

E. *Drilled Shaft Preconstruction Conference.* Hold a drilled shaft preconstruction conference at least five Working Days prior to the Contractor beginning any shaft construction Work at the site to discuss investigative boring information, construction procedures, personnel, and Equipment to be used, and other elements of the accepted Shaft Installation Plan as specified in Section 606.03.1.B. of this Specification. If

slurry is used to construct the shafts, the frequency of scheduled site visits to the project site by the slurry manufacturer's representative will be discussed. Those attending must include:

1. The Superintendent, on-site supervisors, and other key personnel identified by the Contractor as being in charge of excavating the shaft, placing the casing and slurry as applicable, placing the steel reinforcing bars, and placing the concrete. If slurry is used to construct the shafts, the slurry manufacturer's representative and a Contractor's employee trained in the use of the slurry, as identified to the Engineer in accordance with Section 606.03.4.D.1. of this Specification, must also attend.
2. The Project Engineer, key inspection personnel, and appropriate representatives of the Department.

If the Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved Drilled Shaft Installation Plan, an additional conference may be held at the request of the Engineer before any additional shaft construction operations are performed.

F. *Logs of Shaft Construction*. Prepare inspection logs documenting each shaft construction activity, including casing installation, excavation, shaft bottom inspection, reinforcement installation and concrete placement. Fully document the work performed with frequent reference to the date, time and casing/excavation elevation in the logs. In addition, prepare and submit the logs documenting any subsurface investigation borings or rock core holes performed for the Contract at drilled shaft foundation locations.

In the records for temporary and permanent casings, include at least the following information:

1. Identification number and location of the shaft.
2. Diameter and wall thickness of the casing.
3. Dimensions of any casing reinforcement.
4. Top and bottom elevations of the casing.
5. Method and Equipment used for casing installation.
6. Any problems encountered during casing installation.
7. Name of the Inspector.

In the shaft excavation log, include at least the following information:

1. Identification number, location and surface elevation of the shaft.
2. Description and approximate top and bottom elevation of each soil or rock material encountered.
3. Seepage or groundwater conditions.
4. Type and dimensions of tools and Equipment used, and any changes to the tools and Equipment.
5. Type of drilling fluid used, if any, and the results of slurry tests.
6. Any problems encountered.
7. Elevation of any changes in the shaft diameter.
8. Method used for bottom cleaning.
9. Final bottom elevation of the shaft.
10. Name of the Inspector and the date, time and name of any changes in the Inspector.

In the concrete placement records, include at least the following information:

1. Concrete mix used.
2. Time of start and end of concrete placement.
3. Volume and start/end time for each truck load placed.
4. Concrete test results.

5. Concrete surface elevation and corresponding tremie tip elevation periodically during concrete placement.
6. Concrete yield curve (volume versus concrete elevation, actual and theoretical).
7. Name of the Inspector.

Submit the logs for each shaft construction activity to the Engineer within 24 hours of the completion of that activity. Submit a full set of shaft inspection logs for an individual drilled shaft to the Engineer within 48 hours of the completion of concrete placement at the shaft.

606.03.2 Drilled Shaft Excavation. Excavate the drilled shafts to the required depth as shown in the Contract Documents or as directed by the Engineer. Once the excavation operation has been started, conduct the excavation in a continuous operation until the excavation of the shaft is completed, except for pauses and stops as noted, using approved Equipment capable of excavating through the type of material expected. Provide temporary casing at the site in sufficient quantities to meet the needs of the anticipated construction method.

Pauses, defined as interruptions of the excavation operation, will be allowed only for casing splicing and removal of obstructions. Drilled shaft excavation operation interruptions not conforming to this definition are considered as stops.

If the drilled shaft excavation is not complete at the end of the shift or series of continuous shifts, the drilled shaft excavation operation may be stopped, provided the Contractor, before the end of the Work Day, protects the shaft as indicated in Section 606.03.3. of this Specification.

If slurry is present in the shaft excavation, conform to the requirements of Section 606.03.4.D.2. of this Specification regarding the maintenance of the minimum level of drilling slurry throughout the stoppage of the shaft excavation operation, and recondition the slurry to the required slurry properties in accordance with Section 606.02 of this Specification prior to recommencing shaft excavation operations.

Ensure the excavation and drilling Equipment have adequate capacity, including power, torque and down thrust to excavate a hole of both the maximum diameter and to a depth of 20 feet, or 20 percent, beyond the maximum shaft length shown in the Contract Documents, whichever is greater.

Blasting will only be permitted if specifically stated in the Contract Documents or authorized in writing by the Engineer.

Perform sidewall overreaming when the time for shaft excavation exceeds 36 hours or as directed by the Engineer (measured from the beginning of excavation below the casing when casing is used) before the start of concrete placement. Also perform sidewall overreaming when the sidewall of the hole is determined by the Engineer to have softened due to the excavation methods, swelled due to delays in the start of concrete placement, or degraded because of slurry cake buildup. Overreaming thickness must be a minimum of 1/2 inch and a maximum of 3 inches. Overreaming may be accomplished with a grooving tool, overreaming bucket, or other Equipment approved by the Engineer. If overreaming is required as a result of the excavation time exceeding the time limit specified herein, or as a result of excavation methods not in compliance with the approved Drilled Shaft Installation Plan, the Contractor will solely bear the costs associated with both sidewall overreaming and additional drilled shaft concrete related to overreaming.

Complete excavation to the foundation cap elevation before drilled shaft construction begins, unless otherwise noted in the Contract Documents or approved by the Engineer. Any disturbance to the foundation cap area caused by shaft installation will be repaired by the Contractor prior to placing the cap concrete.

When drilled shafts are to be installed in conjunction with Embankment construction, construct drilled shafts after placement of the Embankment fill unless otherwise shown in the Contract Documents or approved by the Engineer. Do not cap the drilled shafts installed prior to the completion of the Embankment fill until the fill has been placed to the bottom of cap level.

606.03.3 Drilled Shaft Excavation Protection. Do not leave drilled shaft excavations open overnight unless cased full depth or otherwise protected against sidewall instability. An open excavation is defined as a drilled shaft that has not been filled with concrete, or temporarily backfilled with a Material approved by the Engineer in accordance with

Section 606.03.1.B of this Specification or protected in accordance with Section 606.03.4. The use of slurry to protect a drilled shaft during a drilling stoppage or overnight shutdown may be approved by the Engineer.

Casing of drilled shafts in stable rock formations during stoppages is not required, unless shown in the Contract Documents or specified herein.

606.03.4 Drilled Shaft Excavation Protection Methods. The Contractor bears full responsibility for selection and execution of the method(s) of stabilizing and maintaining the drilled shaft excavation. Protect the walls and bottom of the drilled shaft excavation so that side wall caving and bottom heave is prevented from occurring, and so that the soil adjacent to the drilled shaft is not disturbed. The Contractor may excavate the drilled shaft without excavation protection provided the Contractor can demonstrate that the soil/rock is stable and above the water table and zones of seepage. Acceptable protection methods include the use of casing, drilling slurry, or both.

A. *Temporary Casing Construction Method*. In stable soils, conduct casing installation and removal operations and drilled shaft excavation operations such that the adjacent soil outside the casing and drilled shaft excavation for the full height of the drilled shaft is not disturbed. Disturbed soil is defined as soil whose geotechnical properties have been changed from those of the original in-situ soil, and whose altered condition adversely affects the performance of the drilled shaft foundation.

   If utilizing casing that is adequately sealed into competent soils such that water cannot enter the excavation, the Contractor may, with the Engineer's approval, continue excavation in soils below the water table provided the water level within the casing does not rise or exhibit flow.

   As the temporary casing is withdrawn, a sufficient head of fluid concrete must be maintained to ensure that water or slurry outside the temporary casing will not breach the column of freshly placed concrete.

   Extract the casing at a slow, uniform rate with the pull in line with the shaft axis. Avoid excessive rotation of the casing to limit deformation of the reinforcing steel cage.

   Remove all temporary casings from the excavation as concrete placement is completed, unless permission has been received from the Engineer to leave specified temporary casings in place.

B. *Permanent Casing Construction Method*. When permanent casing is specified, excavation will conform to the specified outside diameter of the drilled shaft. After the casing has been filled with concrete, fill all void space occurring between the casing and drilled shaft excavation with a Material that approximates the geotechnical properties of the in-situ soils, in accordance with the Drilled Shaft Installation Plan specified in Section 606.03.1.B of this Specification, and as approved by the Engineer.

   When the shaft extends above ground or through a body of water, the portion exposed above ground or through a body of water may be formed with removable casing except when the permanent casing is specified. Strip the removable casing from the shaft in a manner that will not damage the concrete. Casings can be removed when the concrete has attained sufficient strength provided:

   1. The shaft concrete is not exposed to salt water or moving water for 7 Days.
   2. The concrete reaches a compressive strength of at least 2500 pounds per square inch, as determined from concrete cylinder breaks.

   Use of removable casing is permitted only if specified in the Contract Documents or approved by the Engineer. Use removable casing in accordance with the Equipment and procedures shown in the approved Drilled Shaft Installation Plan, and comply with all other requirements specified herein.

C. *Alternative Casing Methods*. When approved by the Engineer, installation of casing using rotating, oscillating, or vibrating methods will be permitted. Use this alternative casing method in accordance with the Equipment and procedures shown in the approved Drilled Shaft Installation Plan, and comply with all other requirements specified herein.

   Equip drilled shaft casing with cutting teeth or a cutting shoe and install by rotating, oscillating, or vibrating the casing.

D. *Slurry*. Use slurry in accordance with Section 606.02 of this Specification to maintain a stable excavation during excavation and concrete placement operations once water begins to enter the drilled shaft excavation and remains present.

Use slurry to maintain stability during drilled shaft excavation and concrete placement operations in the event that water begins to enter the drilled shaft excavation at a rate of greater than twelve inches per hour, or if the Contactor is not able to restrict the amount of water in the drilled shaft to less than three inches prior to concrete placement, or to equilibrate water pressure on the sides and base of the drilled shaft excavation when groundwater is encountered or anticipated based on the available subsurface data.

1. *Slurry Technical Assistance*. If slurry is used, the manufacturer's representative, as identified to the Engineer in accordance with Section 606.03.1.C. of this Specification, must:

   a. Provide technical assistance for the use of the slurry.

   b. Be present at the site prior to introduction of the slurry into a drilled hole.

   c. Remain at the site during the construction and completion of a minimum of one drilled shaft to adjust the slurry mix to the specific site conditions.

After the manufacturer's representative is no longer present at the site, the Contractor's employee trained in the use of the slurry, as identified to the Engineer in accordance with Section 606.03.1.C. of this Specification, must be present at the site throughout the remainder of shaft slurry operations for this project to perform the duties specified above.

2. *Minimum Level of Slurry in the Excavation*. When slurry is used to maintain a stable excavation, maintain the slurry level in the excavation to obtain hydrostatic equilibrium throughout the construction operation at a height required to provide and maintain a stable hole, but not less than 5 feet above the water table or surface of surrounding water body if at an offshore location.

   Provide casing, or other means, as necessary to meet these requirements.

   Maintain the slurry level above all unstable zones a sufficient distance to prevent bottom heave, caving, or sloughing of those zones.

   Throughout all stops in drilled shaft excavation operations, monitor and maintain the slurry level in the excavation the greater of the following elevations:

   a. No lower than the water level elevation outside the drilled shaft.

   b. Elevation as required to provide and maintain a stable hole.

3. *Cleaning Slurry*. Clean, re-circulate, de-sand, or replace the slurry, as needed, in order to maintain the required slurry properties. Sand content will only be required to be within specified limits immediately prior to concrete placement.

606.03.5 Obstructions. When obstructions are encountered, notify the Engineer promptly. An obstruction is defined as a specific object (including, but not limited to, boulders, logs, and man-made objects) encountered during the drilled shaft excavation operation that prevents or hinders the advance of the drilled shaft excavation. When efforts to advance past the obstruction to the design drilled shaft tip elevation result in the rate of advance of the drilled shaft drilling Equipment being significantly reduced relative to the rate of advance for the portion of the drilled shaft excavation in the geological unit that contains the obstruction, then remove, bypass or break up the obstruction under force account. Blasting will not be permitted unless approved in writing by the Engineer.

Drilling tools that are lost in the excavation will not be considered obstructions, and will be promptly removed by the Contractor. All costs due to lost tool removal will be borne solely by the Contractor including, but not limited to, costs associated with the repair of hole degradation due to removal operations or an excessive time that the hole remains open.

606.03.6 Protection of Existing Structures. Control operations to prevent damage to existing Structures, utilities, roadways, and other facilities. Include preventive measures, which include, but are not limited to, selecting construction methods and procedures that will prevent excessive caving of the drilled shaft excavation and

monitoring and controlling the vibrations from the driving of casing or sheeting, drilling of the shaft, or from blasting, if permitted by the Engineer.

606.03.7 Slurry Sampling and Testing. Mix and thoroughly hydrate mineral slurry and polymer slurry in slurry tanks, lined ponds, or storage areas. Draw sample sets from the slurry storage facility and test the samples for conformance with the appropriate specified Material properties before beginning slurry placement in the drilled hole. Ensure that the slurry conforms to the quality control plan included in the Drilled Shaft Installation Plan in accordance with Section 606.03.1.B. of this Specification and as approved by the Engineer. A sample set must be composed of samples taken at mid-height and within two feet of the bottom of the storage area.

Sample and test all slurry in the presence of the Engineer, unless otherwise approved by the Engineer. Record the date, time, names of the persons sampling and testing the slurry, and the results of the tests. Submit a copy of the recorded slurry test results to the Engineer at the completion of each drilled shaft, and during construction of each drilled shaft when requested by the Engineer.

Take and test sample sets of all slurry, composed of samples taken at mid-height and within two feet of the bottom of the drilled shaft, during drilling as necessary to verify the control of the properties of the slurry. As a minimum, take and test the sample sets of polymer slurry at least once every four hours after beginning its use during each shift.

Take and test sample sets of all slurry, as specified, immediately prior to placing concrete.

Demonstrate to the satisfaction of the Engineer that stable conditions are being maintained. If the Engineer determines that stable conditions are not being maintained, immediately take action to stabilize the shaft. Submit a revised Drilled Shaft Installation Plan that addresses the problem and prevents future instability. Do not continue with drilled shaft construction until the damage that has already occurred is repaired in accordance with the Specifications, and until receiving the Engineer's approval of the revised Drilled Shaft Installation Plan.

606.03.8 Drilled Shaft Excavation Inspection. Use appropriate means, such as a cleanout bucket, air lift, or hydraulic pump, to clean the bottom of the excavation of all drilled shafts. The base of the drilled shaft excavation cannot be covered with more than three inches of sediment or loose or disturbed material just prior to placing concrete in soil shafts or more than one-half inch for 50 percent of the shaft area in rock sockets.

The excavated drilled shaft will be inspected and approved by the Engineer prior to proceeding with construction. Sound the bottom of the excavated drilled shaft with an airlift pipe, a tape with a heavy weight attached to the end of the tape, a borehole camera with visual sediment depth measurement gauge, or other means acceptable to the Engineer, to determine that the drilled shaft bottom meets the requirements in the Contract Documents.

606.03.9 Assembly and Placement of Reinforcing Steel. Prior to and during fabrication of the steel reinforcing cage, support the reinforcing bars off the ground surface, and protect the reinforcing bars from contamination with mud and other deleterious materials.

Rigidly brace the reinforcing cage to retain its configuration during handling and construction. Individual or loose bars will not be permitted. Tie all (100 percent) intersections of vertical and horizontal bars. Show bracing and any extra reinforcing steel required for fabrication of the cage on the Working Drawings.

Carefully position and securely fasten the reinforcement to provide the minimum clearances specified or shown in the Contract Documents, and to ensure that no displacement of the reinforcing steel cage occurs during placement of the concrete.

Splicing of the reinforcement cage during placement of the cage in the shaft excavation will not be permitted unless otherwise shown in the Contract Documents or approved by the Engineer.

Bundle vertical bars when necessary to maximize clear space between vertical reinforcement bars. Use rolled hoops or bundled spirals when necessary to maximize clear space between horizontal reinforcement.

If the reinforcing cage is spliced during placement of the cage into the drilled shaft excavation, the splice details and location of the splices must be in accordance with the Contract Documents and the approved Drilled Shaft Installation Plan. In addition, perform the Work within the time limits specified in Section 606.03.1.

Securely hold the steel reinforcing cage in position throughout the concrete placement operation. Tie and support the reinforcing steel in the drilled shaft so that the location of the reinforcing steel will remain within allowable tolerance. Use concrete spacers or other approved non-corrosive spacing devices at sufficient intervals (near the bottom, the top and at intervals not exceeding 10 feet vertically) to ensure concentric spacing for the entire cage length. The number of spacers required at each level will be one spacer for each foot of excavation diameter, with a minimum of four spacers at each level. The spacers must be of adequate dimension to ensure an annular space between the outside of the reinforcing cage and the side of the excavation along the entire length of the drilled shaft as shown in the Contract Documents. Provide acceptable feet made of plastic, or concrete (bottom supports) to ensure that the bottom of the cage is maintained at the proper distance above the base of the excavation unless the cage is suspended from a fixed base during the concrete pour.

Remove bracing steel that constricts the interior of the reinforcing cage after lifting the cage if freefall concrete or wet tremie methods of concrete placement are to be used.

Check the elevation of the top of the steel cage before and after the concrete is placed. If the upward displacement of the rebar cage exceeds 2 inches, or if the downward displacement exceeds 6 inches, the drilled shaft will be considered defective. Make corrections to the satisfaction of the Engineer. Do not construct additional drilled shafts until the rebar cage support has been modified in a manner satisfactory to the Engineer.

606.03.10 Concrete Placement, Curing and Protection. Commence the concrete placement as soon as possible after completion of drilled shaft excavation by the Contractor and inspection by the Engineer. Continue the concrete placement in one operation to the top of the drilled shaft, or as shown in the Contract Documents.

If water is not present (a dry shaft), deposit the concrete through the center of the reinforcement cage by a method that prevents segregation of aggregates. Place the concrete such that the free-fall is vertical down the center of the drilled shaft without hitting the sides, the steel reinforcing bars, or the steel reinforcing bar cage bracing.

If water exists in amounts greater than three inches in depth or enters at a rate of more than twelve inches per hour, then fill the drilled shaft excavation with slurry to at least the level specified in Section 606.03.4.D.2. and with concrete placed by tremie methods.

Do not exceed the time limit for concrete placement as defined in the approved Drilled Shaft Installation Plan and demonstrated by a successful technique shaft or test shaft. Commence the concrete placement time at the mixing of the concrete and extend through to the completion of placement of the concrete in the drilled shaft excavation, including removal of any temporary casing. For wet placement methods, the placement time starts at the batching of the initial load of concrete to be placed in the shaft. Prior to concrete placement, provide test results of both a trial mix and a slump loss test conducted by an approved testing laboratory using approved methods to demonstrate that the concrete meets this defined placement time limit. Maintain the concrete mix with a slump of 4 inches or greater over the defined placement time limit as demonstrated by trial mix and slump loss tests. Conduct the trial mix and slump loss tests at ambient temperatures appropriate for site conditions. Ambient air temperature at the time of concrete placement is not permitted to be greater than the ambient temperature at the time of the concrete trial tests and slump loss tests.

Use only concrete mix design approved for use and included with the approved Drilled Shaft Installation Plan. Adjust all admixtures, when approved for use, for the conditions encountered on the job so the concrete remains in a workable plastic state throughout placement.

Throughout the underwater concrete placement operation, the discharge end of the tube must remain immersed in the concrete at a depth to prevent water from entering. The concrete placement must be continuous until the Work is completed, resulting in a seamless, uniform shaft. If the concrete placement operation is interrupted, the Engineer may require the Contractor to prove by core drilling or other tests that the drilled shaft contains no voids or horizontal joints. If testing reveals voids or joints, repair them or replace the drilled shaft at no expense to the Department. Responsibility for coring and testing costs, and calculation of time extension, will be in accordance with Section 606.03.13. of this Specification.

Before placing any fresh concrete against concrete deposited in water or slurry (construction joint), remove all scum, laitance, loose gravel and sediment on the surface of the concrete deposited in water or slurry, and chip off any high

spots on the surface of the existing concrete that would prevent any steel reinforcing bar cage from being placed in the position required by the Contract Documents.

Complete a concrete yield plot for each wet shaft poured by tremie methods. Submit yield plot to the Department within twenty four (24) hours of completion of the concrete pour.

Do not perform casing installation or drilled shaft excavation operations within a clear distance of three diameters of a newly poured drilled shaft within twenty (24) hours of the placement of concrete and only when the concrete has reached a minimum compressive strength of 1800 pounds per square inch.

606.03.11Tremies. When placing concrete underwater, use a concrete pump or gravity tremie. A tremie must have a hopper at the top that empties into a watertight tube at least eight inches in diameter. If a pump is used, a watertight tube must be used with a minimum diameter of four inches. The discharge end of the tube on the tremie or concrete pump line must include a device to seal out water while the tube is first filled with concrete. In lieu of a seal at the discharge end of the pipe, the Contractor may opt to place a “Pig” or “Rabbit” in the hopper prior to concrete placement which moves through the tremie when pushed by the concrete, forcing water or slurry from the tremie pipe.

Do not use hopper and tubes that contain aluminum parts that will have contact with the concrete. The inside and outside surfaces of the tubes must be clean and smooth to allow both flow of concrete and the unimpeded withdrawal of the tube during concrete placement.

606.03.12 Drilled Shaft Construction Tolerances. Construct the drilled shafts so that the center of the poured shaft at the top of the drilled shaft or mudline, whichever is lower, is within the following horizontal tolerances:

Drilled Shaft Diameter	Tolerance
Greater than 24 inches and less than 60 inches	4 inches
60 inches or larger	6 inches

Drilled shafts in soil must be within 1.5 percent of plumb. Drilled shafts in rock must be within 2.0 percent of plumb. Plumbness will be measured from the top of poured drilled shaft elevation or mudline, whichever is lower.

During drilling or excavation of the drilled shaft, make frequent checks on the plumbness, alignment, and dimensions of the drilled shaft. Submit procedure for correction of any deviations exceeding the allowable tolerances, for approval. Correct any deviations in accordance with the approved procedure.

Do not allow the drilled shaft steel reinforcing bars to be higher than six inches above or three inches below the elevation shown in the Contract Documents.

The reinforcing cage must be concentric with the drilled shaft excavation within a tolerance of 1-1/2 inches.

The top elevation of the completed drilled shaft shall be within a tolerance of plus one inch or minus three inches.

Do not allow the diameter of the drilled shaft to be less than the diameter shown in the Contract Documents.

Ensure that tolerances for casings are in accordance with American Petroleum Institute (API) tolerances applicable to regular steel pipe.

Drilled shaft excavations and completed drilled shafts not constructed within the required tolerances will be considered defective. The Contractor is responsible for correcting all defective drilled shafts to the satisfaction of the Engineer. Submit redesign drawings and computations, signed by a registered Professional Engineer licensed in the State of Delaware. Materials and Work necessary, including engineering analysis and redesign, to complete corrections for out-of-tolerance drilled shafts will be furnished without cost to the Department and without an extension of the Completion date of the Project.

606.03.13 Integrity Testing. Crosshole sonic log (CSL) testing must be performed on all drilled shafts in accordance with ASTM D6760. Accommodate the crosshole sonic log testing by furnishing and installing access tubes.

Install access tubes for crosshole sonic log testing in all drilled shafts, except as otherwise noted herein, to permit access for the crosshole sonic log test probes. If, in the opinion of the Engineer, the condition of the drilled shaft excavation permits drilled shaft construction in the dry, the Engineer may specify that the testing be omitted.

Securely attach the access tubes to the interior of the reinforcement cage of the drilled shaft. Furnish and install one access tube for each foot of drilled shaft diameter, rounded to the nearest whole number, unless otherwise shown in the Contract Documents. A minimum of three tubes will be required. Place the access tubes around the drilled shaft, inside the spiral or hoop reinforcement and three inches clear of the vertical reinforcement, at a uniform spacing measured along the circle passing through the centers of the access tubes. If these minimums cannot be met due to close spacing of the vertical reinforcement, then bundle the access tubes with the vertical reinforcement.

If trimming the cage is required and access tubes for crosshole sonic log testing are attached to the cage, either shift the access tubes up the cage, or cut the access tubes provided that the cut tube ends are adapted to receive the watertight cap as specified.

Install the access tubes in straight alignment and as near to parallel to the vertical axis of the reinforcement cage as possible. Extend the access tubes from the bottom of the drilled shaft to at least two feet above the top of the drilled shaft. Splice joints in the access tubes, if required to achieve full-length access tubes, must be watertight. Clear the access tubes of all debris and extraneous materials before installing the access tubes. Care must be taken to prevent damaging the access tubes during reinforcement cage installation and concrete placement operations in the drilled shaft excavation.

Fill the access tubes with potable water before concrete placement, and reinstall the top watertight, threaded caps.

Prior to performing any crosshole sonic log testing operations specified in this subsection, remove the concrete at the top of the drilled shaft down to sound concrete.

The Department will perform crosshole sonic log testing and analysis on all completed drilled shafts designated for testing by the Engineer. The Department will require advance notice from the Contractor to schedule all crosshole sonic log testing. Provide at least forty eight (48) hours' notice to the Engineer of the time the concrete in each drilled shaft is to be sufficiently cured to allow for crosshole sonic log testing.

The Engineer will determine final acceptance of each drilled shaft, based on the crosshole sonic log test results and analysis for the tested shafts and a review of the visual inspection reports for the subject drilled shaft, and will provide a response to the Contractor within three Working Days after receiving the test results and analysis submittal. Perform the testing after the drilled shaft concrete has cured at least ninety six (96) hours. Additional curing time prior to testing may be required if the drilled shaft concrete contains admixtures, such as a set retarding admixture or a water-reducing admixture. The additional curing time prior to testing required under these circumstances will not serve as grounds for additional compensation or extension of time to the Contractor. Do not perform any subsequent construction on the completed drilled shaft until the CSL tests are approved and the drilled shaft is accepted by the Engineer.

After placing the drilled shaft concrete and before beginning the crosshole sonic log testing of a drilled shaft, inspect the access tubes. Replace each access tube that the test probe cannot pass through, at no cost to the Department, with a two inch diameter hole cored through the concrete for the entire length of the drilled shaft. Unless directed otherwise by the Engineer, locate the cored holes approximately six inches inside the reinforcement and do not damage the drilled shaft reinforcement. Log descriptions of inclusions and voids in cored holes and submit a copy of the log to the Engineer. Findings from cored holes must be preserved, identified as to location, and made available for inspection by the Engineer.

The Engineer will determine final acceptance of each drilled shaft, based on the crosshole sonic log test results and analysis for the tested shafts and a review of the visual inspection reports for the subject drilled shaft, and will provide a response to the Contractor within three Working Days after receiving the test results and analysis submittal.

The Engineer may approve continuing with drilled shaft construction prior to approval and acceptance of the first shaft if the Engineer's observations of the construction of the first shaft are satisfactory, including, but not limited to, conformance to the Drilled Shaft Installation Plan as approved by the Engineer, and the Engineer's review of

Contractor's daily reports and Inspector's daily logs concerning excavation, steel reinforcing bar placement, and concrete placement.

If the Engineer determines that the concrete placed under slurry for a given drilled shaft is structurally inadequate, that drilled shaft will be rejected. The placement of concrete under slurry will be suspended until the Contractor submits to the Engineer written changes to the methods of drilled shaft construction needed to prevent future structurally inadequate drilled shafts, and receives the Engineer's written approval of the submittal.

If the Engineer determines that additional investigation is necessary, or if the Contractor requests, the Engineer may direct that additional testing be performed at a drilled shaft. At the Engineer's request, drill a corehole in any questionable quality drilled shaft (as determined from crosshole sonic log testing and analysis or by observation of the Engineer) to explore the drilled shaft condition. The number, locations, diameter and depth of the core holes and lengths of individual core runs will be determined by the Engineer. Coring procedures must minimize abrasion and erosion of the core samples, and must avoid damage to the steel reinforcement. Log descriptions of inclusions and voids in cored holes and submit a copy of the log to the Engineer. Preserve the recovered core in suitably labeled wood core boxes, identified as to location and depth, and make available for inspection by the Engineer. The Engineer may direct water-pressure testing in the core holes, and/or unconfined compression testing and other laboratory testing on selected samples from the concrete core.

If subsequent testing at a drilled shaft indicates the presence of a defect(s) in the drilled shaft, the testing costs and the delay costs resulting from the additional testing will be borne solely by the Contractor. If this additional testing indicates that the drilled shaft has no defect, the testing costs and the delay costs resulting from the additional testing will be paid by the Department, and, if the drilled shaft construction is on the critical path of the Contractor's Schedule, a time extension equal to the delay created by the additional testing will be granted.

For all drilled shafts determined to be unacceptable, submit a plan for further investigation or remedial action to the Engineer for approval. All modifications to the dimensions of the drilled shafts, as shown in the Contract Documents, required by the investigation and remedial action plan, must be supported by calculations and Working Drawings. All investigation and remedial correction procedures and designs must be prepared by a registered Professional Engineer licensed in the State of Delaware, and submitted to the Engineer for approval. Do not begin repair operations until receiving the Engineer's written approval of the investigation and remedial action plan.

Prior to beginning coring, submit the method and Equipment to be used to drill and remove cores from drilled shaft concrete to the Engineer, and do not begin coring until the Engineer's written approval has been received. Recover the complete core and minimize abrasion and erosion of the core.

Dewater all access tubes and cored holes and fill with grout after tests are completed and the drilled shaft is accepted. Fill the access tubes and cored holes using grout tubes that extend to the bottom of the tube or hole or into the grout already placed. Alternative non-destructive tests such as Gamma-Gamma, Sonic Echo/Impulse Response (ASTM D5882), or Thermal Integrity Profiling (ASTM D7949) may be specified in the Contract Documents or directed by the Engineer to use alongside, or in lieu of, CSL testing. Comply with all requirements for the alternate test methods in accordance with the Contract Documents.

606.03.14 Drilled Shaft Load Tests. Install test shafts at the locations shown in the Contract Documents unless otherwise directed or approved by the Engineer.

Install test shafts to the same dimensions, details, and elevations shown in the Contract Documents, and install using the same Equipment and installation procedures proposed for installation of the foundation drilled shafts.

If the Equipment or procedures are changed following the completion of load testing, install additional load test shafts, and conduct additional load tests as directed by the Engineer at no additional cost to the Department.

Complete all load testing and have the results evaluated by the Engineer before installing any production drilled shafts, unless otherwise authorized by the Engineer.

A. *Static Load Tests*. Perform static load tests in accordance with the procedures specified in ASTM D 1143.

B. *Force Pulse (Rapid) Load Tests*. Perform force pulse (rapid) load tests in accordance with the procedures specified in ASTM D 7383.

C. *Bi-Directional Load Cell Testing*. Install load cells and load test instrumentation in accordance with the bi-directional load cell supplier recommendations, instructions, and procedure manual(s), as approved by the Engineer.

The bi-directional load cells must be capable of expanding to not less than 6 inches while maintaining the applied test load.

Coordinate with the load cell supplier to determine and/or verify all required Equipment, Materials, quantities, procedures, and all other applicable items necessary to complete the load testing shown in the Contract Documents.

Furnish an acceptable pressurized gas source, a hydraulic pump, hydraulic lines, calibrated hydraulic gauge and other Equipment and Material necessary to perform the load tests. Furnish fresh, potable water from an approved source to form the hydraulic fluid used to pressurize the bi-directional load cells.

Furnish, install, and monitor vibrating wire strain gauges as shown in the Contract Documents and as directed by the Engineer. Place the strain gauges in pairs on opposite sides of the reinforcing cage at the elevations shown in the Contract Documents, unless otherwise directed by the Engineer.

Attach two Linear Variable Differential Transformer (LVDT) vibrating wire displacement gauges to each load cell to monitor the expansion and contraction of the load cell. In addition, mount two LVDT gauges on an independent reference beam and set on opposite sides of the top of the test shaft to monitor axial shaft displacement.

Set two telltale rods on the top of each load cell to monitor the displacement of the top of the load cell. The telltale must consist of a 3/8 inch diameter stainless steel rod, greased for reducing friction and corrosion, and placed inside a constant 3/4-inch diameter pipe. Individual sections of telltales must be joint-coupled flush so that each rod is of uniform diameter throughout its length.

Furnish a portable computer and electronic logging Equipment to simultaneously monitor all instrumentation at time intervals designated by the Engineer.

Assemble the load cells, piping, and other attachments in preparation for installation in accordance with the requirements of the bi-directional load cell supplier, unless otherwise specified herein or directed by the Engineer. The following guidelines must be followed.

A. Weld steel top and bottom bearing plates to the load cells. Provide holes through the bearing plates, as appropriate, to facilitate placement of tremie concrete.

B. Coat the upper surface of the bottom steel bearing plate with grease prior to installation into the shaft, to prevent concrete bonding with the bottom plate.

C. Attach the load cells and plate assembly to the reinforcement cage. Securely fasten all hydraulic hoses, telltale casing, slip joints, etc. to the rebar cage. Prior to installation into the drilled shaft excavation, protect the top of any piping to keep dirt, concrete, or other deleterious materials from entering the piping.

D. Limit the deflection of the cage to a maximum of 2 feet between pick points while lifting the cage from the horizontal position to vertical. Provide additional support, bracing, strong backs, etc. to maintain the deflection within the specified tolerance.

For each load test, place the load on the drilled shaft in increments of five percent of the estimated maximum test load shown in the Contract Documents, or until the nominal resistance load (as indicated by the instruments) is approached, or to the maximum capacity of the load cell, whichever occurs first. Unless the maximum capacity of the load cell has been reached, apply increments of 2.5 percent of the estimated maximum test load until the limiting load is attained, or the drilled shaft top displacement reaches 2 inches, or to the maximum extension of the load cell. When the load cell will be used for a subsequent loading stage, the Engineer may interrupt the loading sequence at a load cell opening of approximately 3 inches, or less. Maintain each load increment for a minimum period of 5 minutes, with complete sets of readings obtained and recorded from all gauges and instruments at 1, 2 and 5 minutes after application of the load increment. Apply each increment of load within the minimum length of time practical and take the instrument system readings immediately. It is intended that the addition of a load increment and the completion of the instrument system readings be completed within 5 to 15 minutes. The Engineer may elect to hold the maximum applied load for up to one hour.

Remove the load in decrements of approximately 10 percent of the maximum test load. Remove each decrement of load within the minimum length of time practical and take the instrument system readings immediately. It is intended that the removal of a load decrement and the completion of the instrument system readings be completed within 5 to 15 minutes. The Engineer may also require a reloading cycle with ten loading increments and five unloading decrements. Record the final recovery of the drilled shaft for a period up to one hour after the last unload interval.

Submit a preliminary test report containing the load displacement curves and other test data to the Engineer within three Days of completing each load test. Submit the final report on the load tests to the Engineer within ten Days after completion of each load test. Include at least the following items in the test report:

A. Test shaft identification number and location.

B. Date(s) of testing.

C. Description of the test shaft details, instrumentation, and test procedures.

D. Tables presenting all instrumentation data.

E. Plots of load versus displacement (up and down) for each load cell level, for each stage of the test.

F. Plots of load along the length of the drilled shaft determined from the strain gauge data for at least ten applied load increments.

G. Summary of unit side resistance along the length of the drilled shaft and end bearing resistance.

H. Plots of creep displacement for each load increment.

I. Plot of equivalent top-of-shaft displacement for the test shaft, developed from the load test data.

After completion of the load test to the satisfaction of the Engineer, and when authorized in writing by the Engineer, flush all hydraulic fluid from the bi-directional load cells and hydraulic lines, and replace with cement grout in accordance with the approved Drilled Shaft Installation Plan. Grout any voids remaining outside the load cells after completion of the load test.

606.03.15 Technique Shafts. Demonstrate the adequacy of its methods, techniques, and Equipment by successfully constructing a technique shaft or shafts in accordance with the requirements shown in the Contract Documents. Position the technique shaft(s) at the location(s) shown in the Contract Documents or as directed by the Engineer, but not less than a clear distance of three drilled shaft diameters from the closest production shaft. Drill the technique shaft(s) to the maximum diameter and maximum depth of any production drilled shaft shown in the Contract Documents. Unless shown otherwise in the Contract Documents, reinforce the technique shaft(s) with the same reinforcement as the corresponding size production shaft, and also include CSL tubes as specified herein. Technique shaft(s) must be completed and accepted by the Engineer prior to initiating installation of the load test shafts and foundation drilled shafts. Failure by the Contractor to demonstrate to the Engineer the adequacy of methods and Equipment will be reason for the Engineer to require alterations in Equipment and/or method by the Contractor to eliminate unsatisfactory results. Any additional technique shaft(s) required demonstrating the adequacy of altered methods or construction Equipment will be at no cost to the Department. Once approval has been given by the Engineer to construct production drilled shafts, no changes will be permitted in the methods or Equipment used to construct the satisfactory technique shaft(s) without the written approval of the Engineer.

The technique shaft(s) will be used by the Engineer to determine if the Contractor can:

A. Control dimensions and alignment of excavations within tolerance.

B. Install casing and remove temporary casing.

C. Seal the casing in impervious materials.

D. Control the size of the excavation under caving conditions by the use of a mineral or polymer slurry or by other means.

E. Properly clean the completed drilled shaft excavation.

F. Construct drilled shafts in open water areas.

G. Handle and install reinforcing cages.

H. Satisfactorily place concrete meeting the Specification requirements within the prescribed time limit.

I. Satisfactorily execute any other necessary construction operation.

When authorized in writing by the Engineer, cut off the technique shaft(s) not less than 2 feet below finished grade and leave in place. Restore the disturbed areas at the sites of the technique shaft(s) as nearly as practical to their original condition.

606.04 Method of Measurement.

A. The Engineer will measure drilled shafts by the length in linear feet from the plan top of shaft elevation to the final bottom of shaft elevation. The Engineer will not separately measure excavation, blasting, slurry, reinforcing steel, concrete, grout, integrity testing tubes, or non-destructive testing.

B. The Engineer will measure technique shafts by the length in linear feet from the existing ground surface elevation at the center of the technique shaft hole prior to drilling, to the authorized bottom elevation of the hole. The Engineer will not separately measure excavation, blasting, slurry, reinforcing steel, concrete, grout, integrity testing tubes, or non-destructive testing.

C. The Engineer will measure permanent casing by the length in linear feet of each size casing used, as measured along the casing from the top of the shaft elevation or the top of casing, whichever is lower, to the bottom of the casing.

D. The Engineer will measure load tests by the number of load tests completed according to the specified loading procedures and to the designated maximum load shown in the Contract Documents.

E. The Engineer will measure exploratory drilling by the length in linear feet from the ground elevation where the drilling begins to the bottom of the exploration hole.

606.05 Basis of Payment.

A. The Engineer will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
606000	DRILLED SHAFT, 30"	LF
606001	DRILLED SHAFT, 36"	LF
606002	DRILLED SHAFT, 42"	LF
606003	DRILLED SHAFT, 48"	LF
606004	DRILLED SHAFT, 60"	LF
606005	DRILLED SHAFT, 72"	LF
606010	TECHNIQUE SHAFT, 30"	LF
606011	TECHNIQUE SHAFT, 36"	LF
606012	TECHNIQUE SHAFT, 42"	LF
606013	TECHNIQUE SHAFT, 48"	LF
606014	TECHNIQUE SHAFT, 60"	LF
606015	TECHNIQUE SHAFT, 72"	LF
606020	PERMANENT CASING FOR DRILLED SHAFT, 30" DIAMETER	LF
606021	PERMANENT CASING FOR DRILLED SHAFT, 36" DIAMETER	LF
606022	PERMANENT CASING FOR DRILLED SHAFT, 42" DIAMETER	LF
606023	PERMANENT CASING FOR DRILLED SHAFT, 48" DIAMETER	LF

606024	PERMANENT CASING FOR DRILLED SHAFT, 60" DIAMETER	LF
606025	PERMANENT CASING FOR DRILLED SHAFT, 72" DIAMETER	LF
606030	LOAD TESTING OF DRILLED SHAFTS	EACH
606031	EXPLORATORY DRILLING	LF

B. Such payment is full compensation for furnishing the technical representative, all Materials, Equipment, labor, and incidentals to complete the Work as specified.

C. Load Testing of Drilled Shafts. Payment also includes all costs related to the performance of the load test and for the reporting of procedures and results.

SECTION 607 – MECHANICALLY STABILIZED EARTH WALLS

607.01 Description.

Design, fabricate, furnish, and install mechanically stabilized earth (MSE) walls and modular block retaining walls.

607.02 Materials. Provide Materials as specified in:

MSE Walls	Section 1048
Masonry units / Modular Block Walls	Section 1040

Provide all other Materials for MSE walls or modular block walls as outlined in the Contract Documents or as recommended by the manufacturer.

607.03 Construction.

A. Working Drawings and Design

1. Design wall system in accordance with the specified edition of DelDOT's *Bridge Design Manual* and the specified edition of the *AASHTO LRFD Bridge Design Specifications*. Engineer of Record is responsible for external stability. Wall system designer is responsible for all other limit states for the selected wall system.

2. Prepare and submit Working Drawings for the MSE Walls. Such drawings must be sealed by a Professional Engineer registered in the State of Delaware and must be approved by the Engineer prior to fabrication. Such approval shall not relieve the Contractor of any responsibility under the Contract for the successful completion of Work. The Working Drawings must include, but not be limited to, the following:

   a. Earthwork requirements, including specifications for Material and compaction of backfill.

   b. Details of revisions or additions to drainage systems or other facilities required to accommodate the system.

   c. Details of barriers connected to the wall.

   d. Existing ground elevations, stations, and offsets verified by the Contractor for each location involving construction wholly or partially in original ground or at locations specified in the Contract Documents.

   e. Complete design calculations substantiating that proposed designs satisfy the design parameters in the Contract Documents.

   f. Complete details of all elements required for the proper construction of the retaining wall system, including complete material specifications.

   g. Complete list of Materials.

   h. For modular block walls, include the following:

      i. Length, location, and type of wall.
      ii. Step-by-step process for constructing the wall.

3. Furnish the Engineer a Certificate of Compliance certifying that the furnished Materials comply with the applicable Contract Specifications. Also furnish to the Engineer a copy of all test results performed by the Contractor or his supplier necessary to assure Contract compliance.

B. Excavation and Backfill

1. Excavate to the elevations shown in the Contract Documents in accordance with Section 207. Ensure the work area remains dry in accordance with Section 906.

2. Grade the foundation level for a width equal to or exceeding the length of the reinforcing strips or as required for the retaining wall system.

3. Compact the foundation as directed by the Engineer prior to wall construction. Remove and replace any foundation soils found to be unsuitable, as directed by the Engineer.

4. Simultaneously construct the surrounding earth embankment with the backfill and compact in lifts at the same elevation, meeting density requirements as stipulated in the Contract Documents.

C. Piles

1. Drive piles prior to constructing the wall system unless noted otherwise in the Contract Documents.

D. Leveling Pad

1. At each panel foundation level, provide an unreinforced concrete leveling pad as shown in the Contract Documents. Cure the leveling pad a minimum of 12 hours before placement of wall panels. The concrete finish must be smooth and flat and not vary from the design elevation as shown in the Contract Documents.

2. For modular block walls, construct the foundation element, either a leveling pad or footer, in accordance with the manufacturer's instructions.

E. Wall Erection

1. Place precast concrete panels, constructed in accordance with Section 1048, vertically with the aid of a light crane. Handle panels by means of a lifting device set into the upper edge of the panels, and place in successive horizontal lifts in the sequence shown on the Working Drawings as backfill placement proceeds. As backfill Material is placed behind the panels, maintain the panels in vertical position by means of temporary wooden wedges placed in the joint at the junction of the two adjacent panels on the external side of the wall. External bracing is required for the initial lift.

2. Meet the following tolerances:

   a. Vertical plumbness tolerances and horizontal alignment tolerances cannot exceed 3/4 inch when measured along a 10 foot straight edge.

   b. The maximum allowable offset between precast components shall be 3/4 inch.

   c. The overall vertical plumbness tolerance of the wall from top to bottom cannot exceed 1/2 inch per 10 foot of wall height.

   d. Horizontal and vertical joints between precast components shall not be less than 1/2 inch or more than 1-1/4 inch.

3. Place geotextile fabric and adhesive on the fill face of the panels over each horizontal and vertical joint. Ensure that the fabric extends a minimum of 9 inches onto each panel and is securely adhered to the panels such that no fill can seep through the joint.

4. Install reinforcing mesh/strips after backfill compaction is complete. Place reinforcing mesh/strips normal to the face of the wall, unless otherwise shown in the Contract Documents or as directed by the Engineer.

5. Grout recesses at lifting devices in tops of topmost panels flush with an approved grout as directed by the Engineer except where there is a poured concrete coping or parapet.

6. For modular block walls, construct the wall in accordance with the manufacturer's instructions.

F. Backfill Placement

1. Place backfill to closely follow erection of each course of panels. Place backfill in such a manner as to avoid any damage or disturbance to the wall Materials or misalignment of the facing panels. Place stone for at least the first 3 feet normal to the back face of the panel for the full height of the wall. Remove any wall Materials that become damaged or disturbed during backfill placement and correct or replace as directed by the Engineer at no cost to the Department. Correct any misalignment or distortion of the wall facing panels due to placement of backfill outside the limits of this specification as directed by Engineer.

2. Compact backfill to 95 percent of the maximum density as determined by AASHTO T 99 Method C or D (with oversize correction, as outlined in Note 7, AASHTO T 99).

3. Ensure that the moisture content of the backfill Material prior to and during compaction is uniformly distributed throughout each layer. Place backfill Material with a placement moisture content between optimum moisture content and two percentage points below optimum moisture content. Remove backfill Material with a placement moisture content outside this range and rework until the moisture content is uniformly acceptable throughout the entire lift. Determine the optimum moisture content in accordance with AASHTO T 99 Method C or D (with oversize correction, as outlined in Note 7, AASHTO T 99).

4. The maximum lift thickness after compaction cannot exceed 8 inches. Decrease this lift thickness, if necessary, to obtain the specified density.

5. Achieve compaction within 3 feet of the back face of the wall facing by at least 3 passes of a lightweight mechanical tamper, roller, or vibratory system.

6. At the end of each day's operation, slope the last level of backfill away from the wall facing to rapidly direct runoff of rainwater away from the wall face. In addition, do not allow surface runoff from adjacent areas to enter the wall construction site.

7. For modular block walls, place and compact the backfill Material in accordance with the manufacturer's instructions.

607.04 Method of Measurement.

A. The quantity of Mechanically Stabilized Earth Walls will be measured as the number of square feet of wall placed and accepted. Vertical measurement will be taken from the top of the leveling pad to the bottom of the coping.

B. For projects with multiple walls of varying height and/or material, the quantity of Mechanically Stabilized Earth Walls will not be measured.

C. The quantity of Modular Block Retaining Walls will be measured as the number of square feet of wall placed and accepted. Vertical measurement will be taken from the top of the leveling pad or footer.

607.05 Basis of Payment.

A. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
607000	MECHANICALLY STABILIZED EARTH WALLS	SF
607001	MECHANICALLY STABILIZED EARTH WALLS	LS
607010	MODULAR BLOCK RETAINING WALLS	SF

B. Price and payment for mechanically stabilized earth walls constitutes full compensation for design and all submittals; excavation; dewatering; furnishing and fabricating all Materials for the walls including concrete facing panels, reinforcing strips or mesh, tie strips, geotextiles, adhesives, fasteners, joint Materials; furnishing and placement of backfill Material; concrete leveling pad and coping; and all labor, Materials, and incidentals required to construct the walls.

C. Price and payment for modular block walls constitutes full compensation for design and all submittals, furnishing all Materials, excavation, dewatering, footer or leveling pad, backfill, hauling, fabrication and erection, and for all labor, tools, Equipment and incidentals necessary to complete the Work.

D. Payment for any rock excavation and undercut will be made under separate pay Items.

SECTION 608 – PERMANENT SHEET PILES

608.01 Description.

Fabricate, furnish, and install steel or timber sheet piles.

608.02 Materials.

A. Provide galvanized steel sheet piles in accordance with Section 1032. For connection units, use only units that are compatible with the sheets being joined.

B. Provide timber sheet piles in accordance with Section 1032.

C. Provide concrete for tie-back system in accordance with Section 610 and Section 1022.

D. Provide galvanized steel hardware in accordance with Section 615 and Section 1039.

608.03 Construction.

A. Do not begin installing sheet piles for a bulkhead wall until all muck excavation is complete and backfilled with Borrow Type B to the elevations shown in the Contract Documents.

B. Drive sheet piles into place as to form a permanent, tight Structure. Do not jet steel sheet piles into position. Jetting of timber sheeting is allowed, provided all environmental permits are obtained. After piles are in final position and have attained full bearing, cut off the tops to a straight line at the elevation shown in the Contract Documents or as directed by the Engineer. Remove and dispose of all pile cut-off material. Fill handling holes using a method approved by the Engineer.

C. Where shown in the Contract Documents or directed by the Engineer, brace and align the tops of sheet pile walls by means of wales. Lap and join wales at splices and corners and solidly bolt or fasten together. Construct wales in accordance with Section 615 or 621.

D. Construct tie-back system in accordance with the Contract Documents.

608.04 Method of Measurement.

A. The quantity of steel sheet piles will be measured as the actual number of square feet of sheet piles installed and accepted. No measurement will be made for cut-off material.

B. The quantity of timber sheet piles will be measured as the actual number of thousands of board feet measures of sheet piles installed and accepted. No measurement will be made for cut-off material.

C. The quantity of tie-back systems will not be measured.

608.05 Basis of Payment.

A. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
608000	STEEL SHEET PILES, PZ 22	SF
608001	STEEL SHEET PILES, PZ 27	SF
608002	STEEL SHEET PILES, PZ 35	SF
608003	STEEL SHEET PILES, PZ 40	SF
608010	STEEL SHEET PILES, PZC 13	SF
608011	STEEL SHEET PILES, PZC 18	SF
608012	STEEL SHEET PILES, PZC 26	SF
608013	STEEL SHEET PILES, PZC 39	SF

608020	TIMBER SHEET PILES, TREATED	MFBM
608030	SHEET PILE WALL TIE-BACK SYSTEM	LS

B. Price and payment for steel sheet piles constitutes full compensation for furnishing, placing, and cutting off the sheet piles and for all labor, tools, Equipment, and incidentals required to complete the Work.

C. Price and payment for timber sheet piles constitutes 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.

D. Price and payment for sheet pile tie-back system constitutes full compensation for furnishing all labor, Materials, hardware, tools, Equipment, and incidentals as shown in the Contract Documents or as directed by the Engineer.

E. Payment for excavation and backfilling will be made under the respective pay Items.

F. No payment will be made for pile cut-off material.

SECTION 610 – CONCRETE STRUCTURES

610.01 Description.

Furnish, place, finish, and cure concrete Bridges, Culverts, and miscellaneous Structures, including forms and Falsework.

610.02 Materials. Provide Materials as specified in:

Preformed Elastomeric Compression Seals	Section 1042
Rubber Joint Sealant	Section 1042
Hot Poured Joint Sealer	Section 1042
Preformed Expansion Joint Fillers, Type III	Section 1042
Portland Cement Concrete	Section 1022
Chemical Admixtures	Section 1022
Liquid Membrane Compounds	Section 1022
Polyethylene Sheeting	Section 1022
Waterproof Paper	Section 1022
Mix Composition, Classes A, B, C, and D	Section 1022
Bar Reinforcement	Section 1037
Potable Water	Section 1021
Permanent Steel Bridge Deck Forms and Supports	Section 1039
Pipe for Weep Holes	Section 1049
Waterstops	Section 1049
Form Oil for Concrete Formwork	Section 1049
Epoxy Bonding Compound	See below
Polyurethane Sealant	Section 1042
Grout	Section 1047

610.03 Construction. Provide an American Concrete Institute (ACI) or National Ready Mix Concrete Association (NRMCA) certified concrete flatwork technician to supervise all finishing. Provide proof of the flatwork certification to the Engineer prior to concrete placement.

A. *Quality Control Plan.* If required in the Contract Plans, submit a Contractor Quality Control Plan to verify that all Materials and workmanship meet the requirements of the Contract Documents. Provide detailed personnel, Equipment, methods and procedures to ensure the specified quality of all applicable Materials and related production and field operations. Follow the submittal procedures outlined in Section 105.04 of the Standard Specifications.

Do not commence Work until the Quality Control Plans are approved. Provide sufficient detail in the plan to enable the Engineer to determine the adequacy of the plan. As a minimum, provide the following information in the plan:

1. *Temperature Control Plan.*

a. *Hot and/or Dry Weather.* Provide a hot and/or dry weather Placement and Curing Plan when placing concrete in hot or dry weather. Include as part of the Placement and Curing Plan detailed procedures for measures to reduce the hazards of increased rate of cement hydration, flash set, loss

of water due to evaporation, high concrete ingredient temperatures, and the increased difficulty of concrete placement and finishing, in accordance with the requirements of Section 610.03.D.1.

b. *Cold Weather.* Provide a cold weather Placement and Curing Plan when cold weather is reasonably expected or has occurred within 7 days of anticipated concrete placement (cold weather is defined as any time during the concrete placement or curing period when the ambient temperature at the work site falls below 40 degrees Fahrenheit or the ambient temperature at the site falls below 50 degrees Fahrenheit for a period of 12 hours or more). Include as part of the Placement and Curing Plan detailed procedures for the production, transporting, placing, protecting, curing, and temperature monitoring of concrete during cold weather, in accordance with the requirements of Section 610.03.D.3.

c. *Mass Concrete.* When mass concrete is defined designated in the Contract Documents, provide an analysis of the anticipated thermal developments in the mass concrete elements for all expected project temperature ranges using the selected mix design, casting procedures, and Materials. Use a Specialty Engineer who is a Professional Engineer registered in the State of Delaware, and is competent in the design and temperature control of concrete in mass elements. The Specialty Engineer shall follow the procedure outlined in Section 207 of the ACI Manual of Concrete Practice to formulate, implement, administer and monitor a temperature control plan, making adjustments as necessary to ensure compliance with Section 610.03.J. Provide the plan to the Engineer for approval a minimum of 45 Days prior to the placement of any mass concrete. Include a resume for the Specialty Engineer, detailing relevant experience on at least 5 thermal control projects. Include a minimum of one level of redundancy for all Equipment and Materials to maintain a continuous pour as part of the Contractor's proposal. Submit a copy of any software models used for the prediction of peak temperatures with the site and element specific data to the Engineer for approval with the analysis, including electronic files. Additionally, the proposed plan shall describe the measures and procedures intended to maintain, monitor and control the temperature differential between the interior and exterior of the mass concrete elements, and the maximum temperature.

2. *Concrete Placement Plan*. Provide a Concrete Placement Plan. Include as part of the Placement Plan detailed procedures for the production, transporting, placing, protecting, curing, temperature monitoring and consolidating the concrete mix in approved forms to make a dense homogeneous concrete, in accordance with the requirements of Section 610.03.E. The plan and mix design will address all measures necessary to ensure the quality of the concrete in its final placement will be maintained. Submit a placement plan for placement of concrete by pump. As a minimum, include in the plan pump location, work reach (vertical & horizontal), pump capability, sequence of placement, delivery configuration, contingency for Equipment malfunction.

3. *Bridge Deck Placement Plan*. Submit a Bridge Deck Placement Plan to produce a smooth, durable riding surface of uniform texture, true to the required grade and cross-section, in accordance with the requirements of Section 610.03.E.4. Include as part of the Placement Plan detailed procedures for the production, transporting, placing, protecting, curing, temperature monitoring, consolidating the concrete mix in approved forms to make a dense homogeneous concrete, and contingency for Equipment malfunction.

4. *Construction Joint Plan*. Submit a plan of locations and sequence of construction joints to the Engineer for approval. Construction Joint Plans will include provisions and details for emergency construction joints including but not limited to shear keys, bonding agents, joint sealants, waterstops, and additional reinforcement, in accordance with the requirements of Section 610.03.G.

B. *Falsework and Forms.* For Falsework and forms, meet Section 604.

C. *Permanent Steel Bridge Deck Formwork.* Permanent steel bridge deck forms for concrete deck slabs of Bridges shall be used when shown in the Contract Documents.

1. *SIP Form Plan.* Provide fabrication and erection drawings for SIP Forms. 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. These drawings and all calculations must be signed and sealed by a Professional Engineer registered in the State of Delaware.

2. *Design***.** Meet the following criteria for the design of stay-in-place bridge deck forms:

   a. Include an analysis of the actual unit weight of the proposed forming system over the projected plan area of the metal forms. If the weight thus calculated exceeds the weight allowance for stay-in-place metal forms and concrete required to fill the forms shown in the Contract Documents, submit a method to modify the supporting components to support the excess weight at no additional cost to the Department.

   b. Design the forms on the basis of dead load of form, reinforcement, and plastic concrete plus 50 pounds per square foot for construction loads. Use a unit working stress in the steel sheet of not more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 pounds per square inch.

   c. Do not allow deflection under the weight of the forms, reinforcement, and plastic concrete to exceed 1/180 of the form span or 1/2 inch, whichever is less, for form spans of 10 feet or less, or 1/240 of the form span or 3/4 inch, whichever is less, for form spans greater than 10 feet. In all cases, do not use a total loading (pounds per square foot) that is less than 20 plus the product of the deck thickness measured in inches times 12.5.

   d. Use a design span of the form equal to the clear span of the form plus 2 inches. Measure the span parallel to the form flutes.

   e. Compute physical design properties in accordance with requirements of the AISI Specifications for the Design of Cold Formed Steel Structural Members, latest published edition.

   f. For all reinforcement, maintain the design concrete cover required by the Contract Documents.

   g. Maintain the plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck.

   h. Do not consider the permanent bridge deck form as lateral bracing for compression flanges of supporting structural members.

   i. Secure forms to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel by means other than welding directly to the member.

3. *Construction.* Install all forms in accordance with approved fabrication and erection drawings.

   Do not rest form sheets directly on the top of the stringer of floor beam flanges. Fasten sheets securely to form supports, and maintain a minimum bearing length of 1 inch at each end for metal forms. Place form supports in direct contact with the flange of the stringer or floor beam. Make all attachments for coated metal forms by bolts, clips, screws, or other approved means. However, do not weld form supports to flanges of steels not considered weldable and to portions of a flange subject to tensile stresses. Ensure that welding, welder qualifications, and prequalification of weld details and inspection of welds meet AASHTO/AWS D1.5 Bridge Welding Code, except that 1/8 inch fillet welds will be permitted.

   For any permanent exposed steel where the galvanized coating has been damaged, thoroughly clean, wire brush, and paint it with two coats of galvanizing compound to the satisfaction of the Engineer. Do not touch up minor heat discoloration in areas of welds.

   Lap forms in the direction consistent with the placement of the concrete. Install permanent steel bridge deck forms such that they are mortar tight. Ensure that slurry does not leak through the forms during the deck pour. Responsibility for any damage to persons or property due to leakage through the forms is in accordance with Section 107.10. Additional protection may be placed beneath the forms to catch

leakage during the deck pour if desired. Payment for additional protection or protective shielding will not be made.

D. *Weather and Environmental Conditions.* Protect concrete from damage caused by weather or environmental conditions. Repair or remove and replace any damaged concrete.

Maintain concrete mixture temperature at time of placement between 50 degrees Fahrenheit and 90 degrees Fahrenheit. Maintain concrete mixture temperature for bridge decks at time of placement between 50 degrees Fahrenheit and 85 degrees Fahrenheit.

1. Hot and Dry Weather Requirements. Keep new concrete shaded from the sun, shielded from the wind, and kept wet with water, or protected by other methods to retain the moisture in the concrete throughout the curing period. When placing concrete in hot weather, take appropriate measures to reduce the hazards of increased rate of cement hydration, flash set, loss of water due to evaporation, high concrete ingredient temperatures, and the increased difficulty of concrete placement and finishing.

   a. *Concrete Temperature.* Ensure the temperature of the concrete at the point of discharge does not exceed 90 degrees Fahrenheit. Ensure the temperature of the concrete for bridge decks at the point of discharge does not exceed 85 degrees Fahrenheit.

   b. *Cooling Materials.* If necessary, reduce the temperature of the concrete by cooling one or more ingredients. Cool aggregates by fogging or other suitable means that will not result in a high variation of moisture content within the stockpile. Use chipped or crushed ice in the mix as a portion of the mixing water on a pound for pound basis, provided such measure is determined at the time of placement in the mix. If ice is used, melt before discharging the batch from the mixing unit. Cool water by refrigeration or other means that will provide a uniform mixing water temperature.

   c. *Placing Concrete.* Immediately before placing concrete, cool the forms, reinforcing steel and other surfaces that will be in contact with the concrete by water spray or other approved methods when the ambient temperature rises above 90 degrees Fahrenheit. Ensure there is no standing water in the concrete forms as a result of the spraying procedures. Provide personnel and Equipment in accordance with the approved Placement and Curing Plan to place the concrete without delays that may cause excessive slump loss and evaporation due to over-mixing or exposure before placement.

   d. *Finishing.* Use windscreens of sufficient dimensions, water fogging, or other approved means of supplying moisture to prevent shrinkage cracking due to moisture loss. Maintain finishing operations as close as practicable behind the placing operation so that curing may begin as soon as possible.

   e. *Protecting Bridge Deck.* Protect bridge deck concrete from rapid evaporation during periods of low humidity, wind, or high temperatures by using methods outlined below.

      Limit the evaporation rate of the exposed concrete surface to less than 0.15 pounds per square foot per hour as published in the ACI 305 chart developed by Delmar Bloem. DelDOT Materials and Research Section can provide copies of the chart upon request.

      To maintain the deck surface evaporation rate below 0.15 pounds per square foot per hour, take one or more of the following actions:

      i. Mist the surface of the concrete immediately behind the finishing machine and until the curing cover is applied. Produce a fine fog mist with the nozzle to maintain a sheen of moisture on the concrete surface without ponding. Do not work any applied moisture back into the surface.

      ii. Construct windscreens or enclosures to effectively reduce the wind velocity throughout the area of placement.

      iii. Reduce the temperature of the concrete at placement.

2. *Rainy Weather Requirements.* Under conditions of threatening rain, only place concrete if protection is provided. During rainy weather, properly cover new concrete, as necessary to prevent damage. Provide sufficient Material for covering at the site of the Work for immediate use.

3. *Cold Weather Requirements.* Concrete placement is permitted when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat is above 35 degrees Fahrenheit. Maintain the concrete mixture at a temperature of 55 degrees Fahrenheit or above.

   Ensure Material and Equipment required for cold weather placement and curing protection is available at the project site before placing concrete. Remove snow, ice, and frost from the surfaces, including reinforcement and subgrade against which the concrete is to be placed. Place concrete only when the temperatures of all surfaces that will come into contact with the concrete are at least 35 degrees Fahrenheit and will be maintained at a temperature of 35 degrees Fahrenheit or above during placement.

   a. *Concrete Temperature.* Continuously maintain the concrete surface temperature at or above the required temperatures indicated in Table 610.03-1. for the curing period defined in Section 610.03.I. Monitor maximum and minimum surface temperature with a measuring device that is accurate to within 2 degrees Fahrenheit. Randomly place in an accessible location one temperature measuring device for every 1,500 square feet of concrete surface area being cured.

Table 610.03-1. Surface Temperature Requirements During Curing (U.S. Customary Units)

	Minimum Section Size Dimension			
Property	Under 1 ft	1–3 ft	Over 3 ft up to 6 ft	Over 6 ft
Minimum temperature of concrete during curing period	57°F	54°F	50°F	50°F
Maximum allowable temperature drop in any 24- hour period during curing	50°F	40°F	29°F	20°F

   Heat the Structure uniformly and so that no part of the concrete surface is heated to more than 90 degrees Fahrenheit, and the temperature differential between the interior and exterior of the element does not exceed 30 degrees Fahrenheit. Reduce heat gradually from the Structure so that the temperature will not drop more than 20 degrees Fahrenheit in 8 hours.

   b. *Warming Materials.* Maintain temperature above 55 degrees Fahrenheit by heating aggregate, water, or both. Limit aggregate and water temperature to a maximum of 150 degrees Fahrenheit. Do not heat aggregate by direct gas or oil flame or on sheet metal over fire. Add cement only after the combination of water and aggregate temperature is 100 degrees Fahrenheit or less.

   c. *Heated Enclosures.* Enclosures must be capable of maintaining the temperature of the Work at 50 degrees Fahrenheit. Concrete will be protected from contact with exhaust gases from heaters. Maintain proper humidity for curing.

   d. *Insulation.* Place insulation on the concrete as soon as initial set will permit. Provide insulating blankets faced or covered, top and bottom, with polyethylene or similar waterproofing material. Blankets must be sufficient thickness to maintain the concrete surface temperature at or above the required temperatures indicated in Table 610.03-1. for the curing period defined in Section 610.03.I. Secure blankets around the perimeter of the Work sufficiently to minimize infiltration of ambient air and loss of heat during the protection period. Should the temperature of the Work fall below the required temperatures indicated in Table 610.03-1 during the protection period, take immediate corrective actions.

E. *Placing Concrete.* Place and consolidate the concrete mix in approved forms in accordance with the approved plan. Place concrete within 60 minutes after adding cement to the mix, unless otherwise approved by the Engineer. In preparation for the placing of concrete, remove all sawdust, chips, and other construction debris and extraneous matter from the interior of forms. Remove hardened concrete and foreign matter from

tools, screeds, and conveying Equipment. Clean and clear all surfaces to come in contact with concrete. Moisten the forms with water before placing concrete. Place concrete continuously to prevent unplanned cold joints or damage to newly set concrete. Regulate the placing of concrete so that the pressures caused by the wet concrete do not exceed those used in the design of the forms. Thoroughly work the external surface of all concrete during the placing by means of tools of an approved type. Place concrete in a manner and sequence that does not displace reinforcement. Place concrete into forms in a method that does not segregate the mix from a homogenous consistency. Aluminum will not be permitted as the contact surface for concrete placed through any conveyance. Protect protruding steel for subsequent pours from coating with mortar and paste. Clean any protruding steel upon completion of the pour prior to subsequent pours. Do not harm the surface coating of the reinforcement steel.

Provide adequate lighting for all concrete operations conducted at night. Obtain approval of the lighting system prior to starting the concrete operations.

Place concrete as near as possible to final position. Do not move the concrete laterally with vibrators. Limit lift thickness to 2 feet. Do not exceed the capacity of the vibrators to consolidate and merge the concrete with the previous lift. Use clean, watertight Equipment and Material, but avoid those made of aluminum. Equip chutes on steep slopes with baffles or reverses. Do not place concrete with chute arrangements longer than 25 feet. Discharge concrete within 5 feet of final placement point.

When pumping concrete, provide a conduit system consisting of 5 inches minimum inside diameter pipe. Prime pump with a cementitious grout material. Discharge priming grout into an approved collection area until fresh undiluted concrete is discharging from the pump line. Operate the pump to produce a continuous stream of concrete without air pockets or segregation. When pumping is completed, eject any concrete remaining in the pipeline which is to be used in the Work in such a manner that there will be no contamination of the concrete or separation of the ingredients. Provide samples of concrete to be used for test purposes taken from the discharge end of the conduit system as close as possible to the final position of the concrete.

1. *Setting Anchor Bolts*. Set by template to the indicated elevation and alignment. Limit the threaded projection above the nut to between 3/16 inch and 1 inch.

2. *Consolidating Concrete*. Consolidate all concrete, except underwater or other exempted placements, by mechanical vibration. Use internal vibration, except for thin sections, with forms designed for external vibration. Provide an adequate number of adequately sized vibrators to accomplish the Work, with one or more spare vibrators in case of breakdown. Use immersion-type vibrators featuring heads covered with rubber or other resilient non-metallic material to consolidate concrete reinforced with epoxy-coated reinforcement. Vibrate at point of deposit. Insert vibrators vertically and withdraw slowly to avoid segregation or grout pockets. Vibrate in a uniform pattern spaced less than 1.5 times the radius of visible effectiveness. Avoid vibration of hardened layers below the placement.

3. *Placing Concrete Underwater*. Obtain written approval before depositing concrete underwater, except when cofferdams are used to seal out water. Equalize hydrostatic pressure on cofferdams during placement and cure of concrete to prevent flow of water through cofferdams during this period. Place concrete uniformly in its final position.

   Before placing tremie concrete, ensure the foundation area is level, and all forms and surfaces are free of mud and silt.

   Use a tremie with a smooth interior face; and watertight discharge tube at least 10 inches in diameter, long enough to reach the bottom of the placement, and marked in 1 foot increments. Provide a valve or similar device, including various types of plugs, at the lower end of the discharge tube that closes tightly while the tremie is being charged and lowered into position, and that can be fully opened in the lowered position. Attach tremie tube to a funnel or hopper of at least 1/2 cubic yard capacity to facilitate transfer of concrete to the tremie. Do not use tremie tubes fabricated from aluminum. Furnish at least two tremie tubes to ensure continuous concrete placement. Do not place tremie concrete by pumping directly to the bottom of placement. Place tremie concrete only in the presence of the Engineer.

Maneuver the tremie tube by using an accurately controlled crane or hoist that allows free vertical movement of the discharge end of the tube. Keep the concrete level in the tremie tube stable. Maintain the equilibrium level. Keep the discharge end of the tremie tube fully submerged in the freshly deposited concrete. Keep the tremie tube relatively motionless. Do not move the tremie laterally during concrete placement.

Place tremie concrete in one continuous operation. Place concrete at a rate that prevents aggregate segregation and allows flow over the entire placement area. Keep the top surface of concrete as level as possible. Maintain balanced hydrostatic pressures to prevent form failure and movement of water through the plastic concrete.

Proceed with dewatering only after test specimens cured under similar conditions show sufficient strength. Remove laitance or other unsatisfactory material by scraping, chipping, or other means that will not damage the surface of the concrete.

4. *Bridge Decks.*

   a. *Pre-Pour Meeting.* Prior to any deck concreting, a "pre-pour" meeting will be held with the Contractor and representatives of the Department in attendance. At this time, review the approved Bridge Deck Placement Plan and procedures for deck construction.

   b. *Placing Deck Concrete*. Do not place concrete in bridge decks until the Engineer is satisfied that personnel and Equipment identified in the approved Bridge Deck Placement Plan are available to deliver, place, spread, finish, and cure a minimum of 20 cubic yards 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. Conduct a dry run of the Equipment before placing concrete. Prior to placing bridge deck concrete, check all Falsework and make all necessary adjustments. Place concrete in accordance with the Bridge Deck Placement Plan and procedures discussed at the pre-pour meeting. Place particular emphasis on proper vibration of the concrete to avoid, tears, aggregate silhouettes, honeycomb and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets.

   c. *Finishing Bridge Decks.* Finish bridge decks, approach slabs, and other concrete surfaces for use by traffic to a smooth, skid resistant surface. Provide adequate work bridges for proper performance of the Work, including the application of fog sprays and curing compound, and for inspecting the Work.

      i. Striking Off and Floating. After the concrete is placed and consolidated, finish pavement surfaces using approved power-driven finishing machines. Use hand finish methods when approved for irregular areas.

      Provide 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. Provide screeds of the transverse type and of sufficient weight to strike off the surface at the specified grade. Do not use longitudinal type screeds 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 feet. In no case shall the length of the screed be less than the full length of the span for spans less than 80 feet. When using the longitudinal type screed on independently supported spans exceeding 80 feet in length with a screed length less than the full length of the span, complete the center half of the span, preferably more, first and then complete the remaining portions. Place bulkheads or other substantial supports for the screed over the abutments and/or piers and at the terminal point of placements within the span. Do not use the surface of a previously placed section 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 in the Contract Documents.

Unless a longitudinal construction joint is approved under the construction joint plan, transverse screeds shall extend the full width of the deck between curbs and/or parapets. Set the screed and transverse construction joints parallel to the nearest support lines (abutment or pier). If the skew angle changes at supports, adjust the angle of the screed accordingly as the finishing machine progresses across the deck slab. When a transverse screed is used, provide a screed of 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, place the portion on either side of the joint and finish 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, elevate the rails a sufficient distance above the deck to permit the simultaneous finishing by hand of any portion not finished by the screed. Fabricate and install rail supports extending above the roadway surface in such a manner as to permit their removal to at least 2 inches 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 or other approved corrosion resistant material. Where rail supports are placed in that portion of the deck under the curbs or parapets, place the supports so that they will be at least 2 inches from the face of the curb or parapet walls or outside edge of the slab.

Ensure that supports for screeds or finishing are completely in place and firmly secured before placement of concrete will be permitted. Set supports to elevations necessary to obtain a bridge deck true to the required grade and cross-section, with allowance being made for anticipated settlement. Provide supports of a type and so installed that no springing or deflection will occur under the weight of the finishing Equipment, and so located that finishing Equipment may operate without interruption over the entire bridge deck being furnished.

On continuous steel beam or girder spans, cast the deck in the order as shown in the Contract Documents. On simple spans, and for any section between construction joints for continuous spans, the concrete may be placed by beginning at the end and working along the roadway or by beginning at the side and working across the roadway. During the screeding operation, keep an adequate supply of concrete ahead of the screed and maintain a slight excess immediately in front of the screed. Use only a work bridge or other suitable platform to perform screeding, finishing, and curing operations without delay. Support the work bridge or platform outside the limits of the concreting. Where the concrete in the deck of a continuous beam or girder span group cannot be placed in one operation, locate construction joints and place the deck in accordance with an approved placement schedule. After the initial placement has been made in any one group of a continuous span, do not make any placement until all previously placed concrete in the deck of that group has been in place until the cylinder strength is at least $0.5\,f'_c$.

After striking off the concrete, finish the surface with a float, roller, or other approved device to remove local irregularities and to leave sufficient mortar at the surface of the concrete for subsequent texturing. Finish the surface without adding water.

ii. *Straightedging*. Check the surface with a 10 foot metal straightedge placed parallel to the centerline of the bridge, or a California-type profilograph. Overlap the straightedge one-half the length of the preceding pass as the checking progresses.

iii. *Surface Testing and Correction*. Inspect finished deck roadway surfaces that will not be overlaid with a wearing surface. Mark variations in the surface that exceed 1/4 inch from a 10 foot straightedge. Correct marked irregularities with a concrete plane or grooving Equipment to produce a textured surface equal in roughness to the surrounding unground concrete without shattering or otherwise damaging the remaining concrete.

iv. *Texturing*. Texture bridge deck, approach slab, and transition slab surfaces by first dragging a fabric over the final screeded concrete and then by sawing longitudinal grooves in the cured

concrete. After final screeding of the surface, 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 at least 75 percent of f'_c, saw uniformly pronounced grooves parallel to the centerlines without damaging the concrete deck surface. Complete a longitudinal grooving operation that results in a uniformly grooved deck surface. Saw grooves approximately 1/8 inch + 0 inch, - 1/16 inch wide, 3/16 inch ± 1/16 inch deep, and on 3/4 inch ± 1/16 inch (nominal) centers. Terminate grooves 18 inches ± 1 inch from the face of the parapet or curb line. If metal drainage inlets extend more than 18 inches from the parapet or curb line, all grooves on the bridge deck surface are to end within 6 inches of the drainage inlet perimeter. At skewed metal edged expansion joints, end all grooves within 6 inches of the joint leaving no ungrooved surface adjacent to each side of the joint greater than 6 inches in width on the deck side of the expansion joints. Produce grooves that are continuous across construction joints or other joints in the concrete deck surface less than 1/2 inch wide.

v. Perform continuous removal of all waste materials, including slurry, resulting from the grooving operations in accordance with Sections 106.08 and 104.14, leaving all surfaces in a washed and clean condition.

5. *Chamfers*. Provide 3/4 inch chamfers at all exposed edges unless specified otherwise on the Plans.

6. *Subfoundation Concrete*.

Subfoundation concrete does not require reinforcement and need not be vibrated. Use Class C concrete for subfoundation concrete.

F. *Slip-Forming Bridge Barrier*. Do not slip form bridge barrier unless allowed by Special Provisions included in the Contract Documents.

G. *Joints.*

1. *Construction Joints*. Place construction joints only at locations shown in the Contract Documents, in accordance with the Construction Joint Plan.

Construct 2 inch x 4 inch keyed construction shear keys at vertical joints and at horizontal joints, unless shown otherwise in the Plans. Rough float the horizontal construction joints to consolidate the surface. Leave the joint in a roughened condition. Form depressions for shear keys covering approximately one third of the contact surface. Bevel the forms for keys so that removal will not damage the concrete. Clean construction joints of surface laitance, curing compound, and other foreign materials before placing fresh concrete against the surface of the joint. Use abrasive blast or other approved methods to clean horizontal construction joints to expose clean aggregate. Flush construction joints with water and allow to dry to a saturated surface dry condition immediately before placing concrete.

Insert an approved continuous waterstop where specified in the Contract Documents. Place the waterstop not less than 3 inches from the face of the concrete. Extend the waterstop into each section of the concrete a distance of not less than 2 inches or as specified in the Contract Documents.

Bond new concrete to existing clean concrete Structures with epoxy bonding compound at locations identified in the Construction Joint Plan. Apply epoxy bonding compound in accordance with manufacturer recommendations.

Form the face edges of all joints exposed to view with straight bulkheads or grade strips, and finish true to line and elevation. All exposed construction joint edges shall have a 3/4 inch v-notch. Construct all construction joints so that feather edging does not occur.

2. *Expansion and Contraction Joints.* Construct expansion and contraction joints to include open joints, filled joints, keyed joints, joints sealed with sealants or waterstops, and joints with combinations of these features.

Finish open joints in decks and sidewalks with an edging tool, when not protected by metal armor. Remove mortar and other debris from open joints.

Construct filled joints with preformed or premolded fillers unless polystyrene board is specified. Use a single piece of joint filler for each joint. Anchor joint filler Material to one side of the joint by waterproof adhesive to prevent it from working out of the joint; take care not to interfere with the compression of the Material.

Provide waterstops as specified in the Contract Documents, and of a type allowing joint movement without injury to the joint Material. Splice, weld, or solder joints to be continuous and watertight. Prevent contamination of waterstop surfaces from oil, grease, dried mortar, or other foreign matter while the waterstop is being embedded in concrete. Ensure that all portions of the waterstop designed for embedment are tightly enclosed by dense concrete.

H. *Finishing Plastic Concrete.* Strike off surfaces of concrete that are not placed against forms to the planned elevation or slope, and finish the surface by floating with a wooden float to seal the surface. Tool construction and expansion joints with an edger. Leave joint filler exposed.

1. *Surface Finishes.*

a. *Pedestrian Walkway Surface Finish.* Strike off and float the surface with wooden, cork or magnesium float. Broom the surface lightly in a transverse direction. Use an edging tool on edges and expansion joints. Lay out sidewalk surfaces in blocks with an approved grooving tool. Correct deviations of more than 1/8 inch when checked with a 5 foot straightedge.

b. -*Brushed Finish.* Brush the surface with a fine brush using parallel strokes.

c. *Surface Under Bearings.*

i. Finish the surface with a float finish where metallic masonry plates are to be placed directly on the concrete or on filler Material less than 1/8 inch thick. Grind the masonry plate contact area to provide full and even bearing.

ii. Finish the concrete surface with a steel trowel when plates will be set on filler Material between 1/8 inch and 1/2 inch thick. Provide a finished surface that varies by no more than 1/16 inch. Grind surfaces that fail to conform to the required flatness.

iii. Finish with a wood float to a flat and even surface free of ridges those surfaces under elastomeric bearings and under metallic masonry plates that are supported on mortar or filler pads 1/2 inch or greater in thickness.

I. *Curing Concrete.* Cure newly placed concrete using one or more of the methods specified below. Keep the surface of the concrete moist by a water fog spray applied without damaging the surface. Commence curing operations immediately after the free water has left the surface and finishing operations are completed.

Cure concrete in accordance with the requirements of Table 610.03-2. Cure concrete bridge decks for 7 uninterrupted days.

1. Curing Methods.

a. *Forms-in-Place Method.* Leave forms in place without loosening them for the cure.

b. *Water Method.* Maintain the concrete surface in a continuously wet condition by ponding, spraying, or covering with Materials that are kept continuously and thoroughly wet. Use cotton mats, multiple layers of burlap, or other approved Materials that do not discolor or otherwise damage the concrete.

c. *Liquid Membrane Curing Compound.* Use Type 2, white pigmented, liquid membranes only on the surfaces of bridge decks, on surfaces that will not be exposed to view in the completed Work, or on surfaces where their use has been approved. Apply the curing solution uniformly at the manufacturer's specified application rate. Do not use liquid membrane curing compounds on surfaces where a rubbed finish is required or on surfaces of construction joints unless the membrane is removed by sandblasting before placing new concrete against the joint.

Seal the exposed concrete immediately after the free water has left the surface. Seal formed surfaces immediately after the forms are removed and the concrete finished. Apply the solution by power operated atomizing spray Equipment in one or two separate applications. Apply the second coating within 30 minutes of the first. Use hand operated sprayers for coating small areas if needed. Thoroughly mix membrane solutions containing pigments. Agitate mixture during application.

Reapply solution, at the specified rate, to membrane film damaged during the curing period by weather or construction activities.

d. *Waterproof Cover Method.* Provide a cover of waterproof sheet material to prevent moisture loss from the concrete. Use this method only when the covering can be secured to prevent moisture loss.

Install the cover when the concrete is wet. Use sheets of the widest practical width, overlap sheets a minimum of 6 inches, and seal tightly with pressure sensitive tape, mastic, glue, or other approved methods to form a waterproof cover over the entire concrete surface. Secure the waterproof sheet material to prevent displacement by wind. Immediately repair sheets torn or damaged during the curing period.

e. *Curing Bridge Decks*. Cure concrete bridge decks in accordance with Section 610.03.I.1.b. for a curing period of at least 7 days after placing concrete.

J. Mass Concrete.

1. *Temperature Control*.

The maximum temperature shall not exceed 160 degrees Fahrenheit during curing. During curing, the maximum differential temperatures shall not exceed:

First 24 hours	30º F
24 to 48 hours	40º F
2 to 7 days	50º F
7 to 14 days	60º F

2. *Monitoring Devices*. Provide temperature monitoring devices to record temperature development between the interior and the exterior of the element at points approved by the Engineer. Monitor a minimum of two independent sets of interior and exterior points for each element to provide redundancy in case of failure of a device. Locate the monitoring points at the geometric center of the element for the interior point and 2 inches from the surface along the shortest line from the geometric center to the nearest surface of the element for the exterior point.

Monitoring devices shall be automatic sensing and recording instruments that record information at a maximum interval of 15 minutes. These devices shall operate for a maximum range of 0 to 200 degrees Fahrenheit with an accuracy of ± 2 degrees Fahrenheit. The readings will begin when the mass concrete placement is complete and continue until the maximum temperature differential is reached and a decreasing temperature differential is confirmed as defined in the temperature control plan. Do not remove the temperature control mechanisms until the core temperature is within 25 degrees Fahrenheit of the ambient temperature. Transmit these readings to the Engineer daily or upon request.

The Specialty Engineer, or a person designated by the Specialty Engineer, must personally inspect and approve the installation of monitoring devices and verify that the process for recording temperature readings is effective for the first placement of each size and type mass component. Submit to the Engineer for approval the qualification of all technicians employed to inspect or monitor mass concrete placements. Designate an employee(s) approved by the Specialty Engineer, as qualified to inspect monitoring device installation, to record temperature readings, to be in contact at all times with the Specialty Engineer if adjustments must be made as a result of the temperature differential or the

maximum allowable temperature being exceeded, and to immediately implement adjustments to temperature control measures as directed by the Specialty Engineer. Provide determined temperature differentials, the summary sheet from the data logger, which includes the maximum temperature, the maximum temperature differential and a final report within three Days of completion of monitoring of each element.

3. *Construction*. Take measures to control differential and absolute temperatures by appropriate use of insulated forms, curing blankets or internal cooling, in accordance with the Temperature Control Plan.

   If either the differential temperature or the maximum allowable temperature is exceeded, the Specialty Engineer shall be available for immediate consultation. If the differential temperature or the maximum allowable temperature has been exceeded, take immediate action as directed by the Specialty Engineer to retard further growth of the temperature differential. Describe methods of preventing thermal shock in the temperature control plan. Use a Specialty Engineer to revise the previously accepted plan to ensure compliance on future placements. Obtain the Engineer's approval of revisions to the approved plan prior to implementation. Do not place any mass concrete until the Engineer has accepted the mass concrete plan(s). When mass concrete temperature differentials or maximum allowable temperature has been exceeded, provide all analyses and test results deemed necessary by the Engineer for determining the structural integrity and durability of the mass concrete element, to the satisfaction of the Engineer. The Department will make no compensation, either monetary or time, for the analyses or tests or any impacts upon the project.

   Repair any cracking or damage due to exceeding maximum temperature and/or temperature differential to the satisfaction of the Engineer at no cost to the Department.

K. *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 610.03-2 and are defined by the strength requirements, unless otherwise noted in the Contract Documents.

Table 610.03-2. 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*
	Strength (%f ‘$_c$)	*Strength (%f ‘$_c$)*	*Strength (%f ‘$_c$)*
Arch [Span ≤ 65’](B.F.)	40	95	95
Arch [Span ≤ 65’](S.F.)	30		
Concrete Beam (B.F.)	60	80	n/a
Concrete Beam (S.F.)	30		
Slab [Span ≤ 10’] and Diaphragms	30	85	n/a
Slab [Span > 10’]	50		
Piers/Columns	30	50	n/a
Pile Cap and Pier Cap	50	60	50
Footing	30	40	30
Cast-In- Place Concrete Piles	n/a	50	n/a
Subfoundation Concrete	20	30	20
Retaining Wall, Headwall, and	30	30	95

Wingwall			
Parapet Wall, Curb, and Backwall	20	20	50
Abutment Wall, Rigid Frame Wall, and Box Culvert Wall	30	50	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.

These strength requirements listed in Table 610.03-2 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 not be 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).

Upon removal of the forms or protection, begin surface cavity repairs, finishing, and curing of the exposed areas immediately.

Except during weather conditions noted above, do not remove the forms for rubbed surfaces longer than 48 hours after placing of the concrete.

The minimum required strength of concrete listed in Table 610.03-2 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 610.03-2, 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.

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. The contractor may supply sure-cure molds in lieu of match curing specimens.

Department personnel will test the cylinders to determine concrete strength at the time the Contractor wishes to remove forms or place loads on the concrete.

Remove all forms whether above or below the ground line or water level.

Do not use methods of form removal likely to cause overstressing of the concrete. Do not remove forms and their supports without the approval of the Engineer.

Remove supports in such a manner as to permit the concrete to take, uniformly and gradually, the stress due to its own weight.

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, remove all form ties used for holding the forms in place and fill the holes, depressions, or small voids thus made which show upon the removal of the forms with cement mortar mixed in the same proportions as that which was used in the body of the Work.

Plan and execute the Work so 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.

Place concrete which is to be exposed to sea water or tidal brackish water in the dry unless otherwise approved. Sea water or brackish water shall not come in direct contact with concrete prior to the times indicated in Table 610.03-3 unless otherwise approved.

Table 610.03-3. 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

L. *Finishing Formed Concrete Surfaces.* Unless otherwise specified in the Contract Documents, provide a Class 1 - Ordinary Surface Finish unless after form removal the formed concrete surfaces 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 Class 2 - Rubbed Finish. Provide finished surfaces as follows:

1. *Class 1—Ordinary Surface Finish*. Finish formed concrete surfaces with a Class 1, ordinary surface finish upon removal of forms. Immediately remove fins and irregular projections from surfaces that are to be exposed or waterproofed. Remove surface bulges or offsets with Carborundum stones or discs. Remove and replace localized poorly bonded rock pockets or honey combed concrete with sound concrete or packed mortar.

   Removal or replacement of portions or all of the Structure may be required if the rock pockets are extensive enough to materially affect the strength of the Structure or reduce the life of the reinforcement.

   Clean and saturate with water all cavities produced by form ties and all other holes, broken corners or edges, and other defects, and then point and true with mortar. For exposed surfaces, add white cement to the mortar to achieve a patch that, when dry, matches the surrounding concrete and is true and uniform. Use mortar in pointing that is less than 1 hour old. Rub the concrete if required or continue curing. Tool and leave construction and expansion joints free of mortar and concrete. Leave the joint filler exposed for its full length with clean and true edges.

2. *Class 2—Rubbed Finish*. Finish exposed surfaces with a Class 2, rubbed finish, except the soffits and the interior faces, and bottoms of concrete girders. Rub concrete as soon as its condition will allow. Allow mortar used in pointing and patching to set before finishing. Rub surfaces with a medium-coarse Carborundum stone, using a small amount of mortar on its face. Mix the mortar using the same proportions of cement and fine sand used in the concrete being finished. Continue rubbing until form marks, projections, and irregularities have been removed, voids have been filled, and a uniform surface has been obtained. Leave the paste produced by this rubbing in place. Produce the final finish by rubbing with a fine Carborundum stone and water. Continue rubbing until the entire surface is of a smooth texture and uniform color. Rub the completed surface with burlap to remove loose powder and leave the surface free from unsound patches, paste, powder, and objectionable marks.

Use a Class 1 finish for metal forms, fiber forms, lined forms, or plywood forms in good condition, and when the Class 1 finish is equal to that which could be attained with the application of a Class 2, Rubbed Finish. Grind with powered disc or sandblast with fine sand to achieve a Class 1 finish when approved.

3. *Class 3—Tooled Finish*. Provide a Class 3, tooled finish, when specified. Finish panels and other similar Work with a bushhammer, pick, or crandall. Conduct Work only after 14 Days or when aggregate cannot be picked out of the surface. Provide a tooled finish surface that shows a grouping of broken aggregate particles in a matrix of mortar, each aggregate particle being in slight relief.

4. *Class 4—Sandblasted Finish*. Provide a Class 4, sandblasted finish, when specified. Sandblast the cured concrete surface with hard, sharp sand to produce an even, fine- grained surface in which the mortar has been cut away, leaving the aggregate exposed.

5. *Class 5—Wire Brushed or Scrubbed Finish*. Provide a Class 5, wire brushed or scrubbed finish, when specified. Scrub the green concrete surface with stiff wire or fiber brushes. Use a muriatic acid solution of 1 part acid to 4 parts water by volume. Remove the cement film or surface, and expose the aggregate particles. Leave an even pebbled texture presenting an appearance ranging from fine granite to coarse conglomerate, depending upon the size and grading of aggregate used. Wash the surface with water mixed with a small amount of ammonia to remove all traces of acid.

M. *Defective Work.* Remove and replace any defective Work discovered after the forms have been removed, except as noted below. 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.

1. *Concrete Strength.* Concrete which fails to reach full 28-day design strength (f'_c) will be considered defective concrete. The Contractor may challenge a concrete test result which fails to reach full 28-day design strength (f'_c) by obtaining cores from the represented Work. Challenge cores must be taken within 5 Working Days of notification by the Department. Cores must be a minimum of 4 inch diameter by 4 inch depth. A minimum of 2 satisfactory cores must be obtained for testing at the central lab. Cut the cores from a location approved by the Engineer. Cores will be immediately handed to a representative of the Department and returned to the Department for testing. The Contractor is entitled to accompany the cores to the central lab and witness all testing.

   If the difference in strength between the challenge cores is greater than 501 pounds per square inch, the core testing result will be considered void and the prorated payment as specified below and corrective action in accordance with Table 610.03-4 will be applied to the concrete in question based upon the field-cast cylinders. Valid compressive strength results of challenge cores will supersede field cylinder results. All decisions regarding structural adequacy, corrective action in accordance with Table 610.03-4, and prorated payment will be based upon results of challenge core results. Structurally inadequate Work must be removed and replaced or reinforced to the satisfaction of the Engineer at no additional cost. Any result determined by the Engineer to be structurally adequate to remain in place may be processed for corrective action and prorated payment in accordance with Table 610.03-4.

TABLE 610.03-4. Corrective Action and Prorated Payment for Concrete Strength.

Category A:	*0 to 250 psi below 28-day Design Strength* No repair required, full payment as specified in Section 610.05.
Category B:	*251 to 500 psi below 28-day Design Strength* Prorated payment as specified below.
Category C:	*501 to 1000 psi below 28-day Design Strength* Prorated payment as specified below 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 or greater below 28-day Design Strength* Strengthen area of low strength concrete as approved by the Engineer at no cost to the Department.

Price Adjustment for Low Strength Concrete. Prorated payment for low strength concrete shall be calculated as shown in the following equation:

$$Prorated\ Payment = \frac{Low\ Compressive\ Strength\ Concrete}{Specified\ Compressive\ Strength} \times Quantity\ of\ Concrete^{*} \times Bid\ Price^{**}$$

[*] The quantity for which the low compressive strength results represent.
[**] Item Bid Price; not Material cost.

2. *Disposition of Cracked Concrete*. The disposition of cracked concrete applies to all cast-in-place concrete members, and once installed, to the precast concrete members that are produced in accordance with Section 612.

   a. *Investigation, Documentation and Monitoring.* The Engineer will inspect concrete surfaces as soon as surfaces are fully visible after casting, with the exception of surfaces of precast concrete products produced in offsite plants, between 7 and 31 days after the component has been burdened with full dead load, and a minimum of 7 days after the bridge has been opened to full unrestricted traffic. The Engineer will measure the width, length and depth of each crack and establish the precise location of the crack termination points relative to permanent reference points on the member. The Engineer will determine if coring of the concrete is necessary when an accurate measurement of crack depth cannot be determined by use of a mechanical probe. The Engineer will monitor and document the growth of individual cracks at an inspection interval determined by the Engineer to determine if cracks are active or dormant after initial inspection. The Engineer will perform all final bridge deck crack measurements once the deck is free of all debris and before longitudinal grooves are cut and after planing is complete for decks that require planing.

   Provide the access, Equipment and personnel needed for the Engineer to safely perform this Work at no expense to the Department. Core cracks for use by the Engineer in locations and to depths specified by the Engineer at no expense to the Department.

   b. *Classification of Cracks.* The Engineer will classify cracks as either nonstructural or structural. Review and comment on the Engineer's crack classification; however, the Engineer will make the final determination.

   c. *Repair Method.* Repair or remove and replace cracked concrete as directed by the Engineer. Additional compensation or a time extension will not be approved for repair or removal and replacement of cracked concrete when the Engineer determines the cause to be the responsibility of the Contractor.

      i. Nonstructural Cracks. Perform all crack repairs in accordance with Sections 613 and 628 of the Standard Specifications.

      ii. Structural Cracks. Provide a structural evaluation signed and sealed by the Contractor's Engineer of Record that includes recommended repair methods and a determination of structural capacity and durability to the Engineer. Upon approval by the Engineer, repair the cracked concrete. Complete all repairs to cracks in a member inside a cofferdam prior to flooding the cofferdam.

610.04 Method of Measurement.

The Engineer will measure Work acceptably completed as specified in Section 109.01 and as follows:

A. The Engineer will use plan quantities to measure concrete.

B. The measurement will include quantities of concrete from fillets, scorings and chamfers of 1 square inch or more in cross-sectional area.

C. No deduction in the computed volume of concrete masonry, except for openings in pipe headwalls, will be made.

610.05 Basis of Payment.

The Department will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
610000	PORTLAND CEMENT CONCRETE MASONRY, CLASS A	CY
610001	PORTLAND CEMENT CONCRETE MASONRY, ABUTMENT FOOTING, CLASS A	CY
610002	PORTLAND CEMENT CONCRETE MASONRY, ABUTMENT ABOVE FOOTING, CLASS A	CY
610003	PORTLAND CEMENT CONCRETE MASONRY, PIER FOOTING, CLASS A	CY
610004	PORTLAND CEMENT CONCRETE MASONRY, PIER ABOVE FOOTING, CLASS A	CY
610005	PORTLAND CEMENT CONCRETE MASONRY, SUBSTRUCTURE, CLASS A	CY
610006	PORTLAND CEMENT CONCRETE MASONRY, APPROACH SLAB, CLASS A	CY
610007	PORTLAND CEMENT CONCRETE MASONRY, SUPERSTRUCTURE, CLASS A	CY
610008	PORTLAND CEMENT CONCRETE MASONRY, PARAPET, CLASS A	CY
610009	PORTLAND CEMENT CONCRETE MASONRY, CLASS B	CY
610010	PORTLAND CEMENT CONCRETE MASONRY, ABUTMENT FOOTING, CLASS B	CY
610011	PORTLAND CEMENT CONCRETE MASONRY, ABUTMENT ABOVE FOOTING, CLASS B	CY
610012	PORTLAND CEMENT CONCRETE MASONRY, PIER FOOTING, CLASS B	CY
610013	PORTLAND CEMENT CONCRETE MASONRY, PIER ABOVE FOOTING, CLASS B	CY
610014	PORTLAND CEMENT CONCRETE MASONRY, SUBSTRUCTURE, CLASS B	CY
610015	PORTLAND CEMENT CONCRETE MASONRY, CLASS C	CY
610016	PORTLAND CEMENT CONCRETE MASONRY, CLASS D	CY
610017	PORTLAND CEMENT CONCRETE MASONRY, SUPERSTRUCTURE, CLASS D	CY
610018	PORTLAND CEMENT CONCRETE MASONRY, APPROACH SLAB, CLASS D	CY
610019	HIGH EARLY STRENGTH CONCRETE	CY
610020	CONCRETE ENCASEMENT	CY

Such payment is full compensation for furnishing all Materials, Formwork, Equipment, labor, and all incidentals required to complete the Work as specified.

SECTION 611 – CONCRETE REINFORCEMENT

611.01 Description.

A. Furnish and place concrete reinforcement.

611.02 Materials. Provide Materials as specified in:

Concrete Reinforcement	Section 1037

611.03 Construction.

A. *Shop Drawings*. Submit Working Drawings in accordance with Section 105.04. Submit detailed bar lists, bending diagrams and type of bar for all bar reinforcement to be furnished. Check all bar lists and details shown in the Contract Documents for accuracy of the quantity, size, length, and dimensions before ordering bars. Bar lists may be prepared on sheets of a size and type that are the supplier's standard.

B. *Storage*. Store reinforcement bars off the ground on platforms, skids, or other supports, and protect the reinforcement bars from mechanical injury and surface deterioration caused by exposure to conditions producing rust. Keep reinforcement bars free from frost, dirt, oil, grease, paint, mortar, loose rust, mill scale, and other materials that would reduce bond. Provide additional protection for specified Materials as follows:

1. *Epoxy-Coated Reinforcing Bars*. Handle and store epoxy-coated reinforcement bars by methods that will not damage the epoxy coating. Furnish all systems for handling epoxy-coated reinforcement bars with adequately padded contact areas if possible. Pad all bundling bands and lift all bundles with a strong-back, multiple supports, or platform bridge to prevent bar-to-bar abrasion from sags in the bar bundle. Do not drop or drag bars or bundles. Transport and store epoxy-coated reinforcement bars on wooden or padded supports.

   Where possible, do not store epoxy-coated reinforcement bars at the jobsite for more than 2 months. If field storage on site is expected to exceed 2 months, cover the epoxy-coated reinforcement bars or bundles with opaque polyethylene or other protective Material. Provide ventilation to prevent condensation from forming under the covering.

2. *Galvanized Reinforcing Bars*. Where possible, do not store galvanized reinforcement bars at the jobsite for more than 30 days. If field storage is expected to exceed 30 days, cover bars with opaque polyethylene or other protective Material. Do not place galvanized reinforcement bars in contact with uncoated reinforcement bars or other uncoated steel or stainless steel.

3. *Stainless Reinforcing Bars*. Do not band strap, or allow direct contact of stainless steel reinforcing bars to non-stainless steel reinforcement bars or other dissimilar metals. Do not store non-stainless steel reinforcement bars or other dissimilar metals above stainless steel reinforcement bars unless adequate protection has been provided to prevent contamination.

4. *Zinc and Epoxy Dual-Coated Reinforcing Bars.* Store in accordance with ASTM A1055.

C. *Bending, Splicing, and Cutting.* Fabricate reinforcing bars as prescribed in the CRSI Manual of Standard Practice. Bend the reinforcement cold to the shapes indicated in the Contract Documents. Perform bending in the shop before shipment and not in the field unless shown otherwise in the Contract Documents. Do not hot-bend or straighten, weld, or thermal-cut reinforcing steel unless otherwise specified in the Contract Documents.

D. *Repair of Coating*.

1. *Epoxy-Coated Reinforcing Bars*. Store, handle, and place epoxy-coated reinforcement bars at the jobsite according to ASTM D3963. Inspect the bars before placement. If the epoxy coating is damaged and the damages do not exceed 2 percent of the surface area in any 1 foot section of the epoxy-coated reinforcement bars, repair all visible damage according to ASTM D3963 before bar placement. Replace epoxy-coated reinforcement bars if damage to the surface area exceeds 2 percent in any 1 foot

section. After placement, inspect the epoxy-coated reinforcement bars again and repair areas damaged during placement.

2. *Galvanized Reinforcing Bars.* After placement, inspect the galvanized reinforcing bars and repair areas damaged during placement in accordance with ASTM A780.

3. *Zinc and Epoxy Dual-Coated Reinforcing Bars.* After placement, inspect the dual-coated reinforcing bars and repair areas damaged during placement in accordance with ASTM A1055.

E. *Placing and Fastening*.

1. General. Accurately place reinforcement bars as indicated and hold it firmly in position during the placing and settling of concrete using metal chairs or acceptable supports. Do not allow bar spacing to vary from the design spacing by more than 1/2 inch. Do not allow the distance from the surface of the formwork to the bars to vary more than 1/4 inch from the design distance. Do not place reinforcement bars closer than 1.5 times the maximum nominal size of the aggregate used in the concrete mix design.

   Firmly tie bars with annealed iron wire or secure the bars with acceptable metal clips. Tie bars at all intersections around the perimeter of each mat, and not less than 2 feet centers or at every intersection, whichever is greater. When all intersections are not tied, tie alternate intersections in each direction to provide a staggered tie layout. Tie bundled bars together at not more than 6-feet centers. Do not bundle more than 2 bars unless noted otherwise in the Contract Documents. When reinforcement bars are tied together and lifted into place as a unit, ensure stability of the unit and maintain proper bar alignment during lifting and placement operations.

   Provide additional protection for ties for specified Materials as follows:

   a. *Epoxy-Coated, Galvanized, or Dual-Coated Reinforcing Bars*. For epoxy-coated, galvanized, or dual-coated reinforcing bars, provide plastic-coated tie wire, epoxy-coated tie wire, metal clips, or plastic clips.

   b. *Stainless Reinforcing Bars*. When tying stainless steel reinforcement bars together, provide plastic, plastic-coated, or stainless steel tie wire in conformance with the requirements of ASTM A493, Type 316 (UNS number S31600). When attaching stainless steel reinforcement bars to non-stainless steel reinforcement bars or any other dissimilar metals, provide 1/8 inch thick (minimum) nylon, polyvinylchloride, or polyethylene spacers or sheathing to ensure non-contact between the reinforcement bars a minimum of 1 inch extending beyond the point of intersection in all directions. Provide nylon or plastic-coated wire ties to bind the spacers and/or reinforcement.

2. *Support Systems*. Support reinforcement bars in their proper position by use of mortar blocks, wire bar supports, supplementary bars, or other devices. Supply such devices of proper height and at sufficiently frequent intervals to maintain the distance between the reinforcement bars and the formed surface or the top surface of deck slabs within 1/4 inch of that indicated.

   Support platforms, which are supporting personnel and Equipment during concrete placement, directly on the forms and not on the reinforcement bars.

   a. *Mortar Block Supports.* Furnish mortar blocks of the same class as the concrete in which they are to be embedded. Ensure that block faces in contact with forms for exposed surfaces do not exceed 2 inches by 2 inches in size, and that their color and texture will match the concrete surface. If used on vertical or sloping surfaces, provide such blocks with an embedded wire for securing the block to the reinforcement bars. If used in slabs, use either a tie wire or, if the gravitational force of the reinforcement bars is sufficient to firmly hold the blocks in place, a groove in the top of the block. For epoxy-coated reinforcement bars or galvanized reinforcement bars, use plastic-coated or epoxy-coated tie wires.

   b. *Wire Supports.* Furnish wire bar supports, such as ferrous metal chairs and bolsters, conforming to industry practice as described in the Manual of Standard Practice of the Concrete Reinforcing Steel Institute. Ensure that chairs or bolsters that bear against the forms for exposed surfaces are

either Class 1 - Maximum Protection (Plastic Protected) or Class 2, Type B - Moderate Protection (Stainless Steel Tipped) for which the stainless steel conforms to ASTM A493, Type 430. For epoxy-coated reinforcement bars or galvanized reinforcement bars, provide plastic-coated, epoxy-coated, or galvanized wire bar supports and bar clips. For stainless steel reinforcement bars, provide plastic supports meeting Section 611.03.E.2.c. or stainless steel bar supports in conformance with the requirements of ASTM A493, Type 316 (UNS number S31600). Use stainless steel supports with plastic-coated feet above steel beams or metal stay-in-place forms.

c. *Plastic Supports.* Use chairs and bolsters that do not deflect more than 1/4 inch under a minimum point load of 350 pounds of force. Use supports molded in a configuration that does not restrict concrete flow.

3. *Splicing and Lapping*. Furnish all reinforcement in the full lengths, as indicated, unless otherwise approved by the Engineer.

Do not splice bars, except as indicated or directed. If splicing is allowed, lap the reinforcement bars as shown in the Contract Documents and as indicated, and wire together securely. Do not substitute alternate bars unless approved by the Engineer. Stagger splices as far as possible.

In lapped splices, place and wire the bars maintaining the minimum distance to the surface of the concrete as indicated. Do not use lapped splices for Nos. 14 and 18 bars, except as provided in the AASHTO LRFD Bridge Specifications.

As indicated in the Contract Documents, use welded splices or mechanical splice systems. Stagger welded splices or mechanical splice system connections if possible.

a. *Welded Splices*. For welded splices, use butt splices only. Only use welded splices if indicated in the Contract Documents or if the Engineer gives written authorization to do so. Ensure that welding conforms to the Structural Welding Code, Reinforcing Steel, AWS D1.4 of the American Welding Society and applicable special provisions. Do not use welded splices on epoxy-coated reinforcement bars or galvanized reinforcement bars. Do not weld close enough to epoxy-coated reinforcement bars to cause any heating of the coating.

b. *Mechanical Splice Systems*. Assemble mechanical splice systems according to the manufacturer's recommendations. Mark reinforcing bars with scribe marks or indelible ink before splice attachment to ensure equal embedment.

If mechanical splice systems are used, construct sample and actual splices in the presence of the Engineer. The Engineer will select, for each size of reinforcement bar used, three splices, either sample or actual, to be tested for verification of physical properties. Submit verification samples to the Department within 7 days of placement. Do not encase mechanical splices in concrete until visual examination and required testing have been completed and approved. Mechanical splices must be capable of resisting 125 percent of the specified yield strength of the bars being spliced.

i. *Epoxy-Coated Mechanical Splice System.* Use an epoxy-coated mechanical splice system to splice epoxy-coated reinforcement bars. Paint the entire splice area with compatible epoxy paint after the system is assembled.

ii. *Galvanized Mechanical Splice System*. Use a galvanized mechanical splice system to splice galvanized reinforcement bars. Galvanize mechanical splice system in accordance with ASTM B695 Class 50, Type II with a minimum thickness of 2 mils or 1.2 ounces per square foot. Chromate in accordance with ASTM A767, Section 4.3.

iii. *Stainless Mechanical Splice System.* Use a stainless steel mechanical splice system to splice stainless steel reinforcement bars meeting the UNS designation listed in Section 611.03.E.1.b. for stainless steel reinforcement bars.

iv. *Splicing of Welded Wire Fabric*. Splice sheets of welded wire fabric by overlapping each other sufficiently to maintain a uniform strength and by securely fastening at the ends and edges. Ensure that the edge lap is at least one mesh in width plus 2 in.

4. *Field-Cut and Field-Bent Reinforcement.* Field-cut or field-bend reinforcing bars when shown in the Contract Documents or when specifically directed by the Engineer. Coat cut ends of coated bars and repair any damage caused by field bending as per the Section 611.03.D.

611.04 Method of Measurement.

A. The Engineer will measure work acceptably completed as specified in Section 109.01 and as follows:

1. The Engineer will compute the theoretical weight of the reinforcing steel placed, excluding from the measurement the weight of wire mesh or clips, wire, separators, wire chairs, and other Material used in fastening the reinforcement in place.

2. The Engineer will exclude the weight of epoxy coating from the measurement of the weight of epoxy-coated reinforcing steel.

611.05 Basis of Payment.

A. The Department will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
611000	BAR REINFORCEMENT	LB
611001	BAR REINFORCEMENT, EPOXY COATED	LB
611002	BAR REINFORCEMENT, GALVANIZED	LB
611003	BAR REINFORCEMENT, STAINLESS STEEL	LB
611004	BAR REINFORCEMENT, ZINC AND EPOXY DUAL-COATED	LB
611010	EPOXY COATED WELDED WIRE FABRIC REINFORCEMENT	LB

B. Such payment is full compensation for furnishing all Materials, Equipment, labor, and incidentals to complete the Work as specified.

SECTION 612 – PRECAST CONCRETE

612.01 Description.

Furnish and erect precast reinforced concrete Culverts, rigid frames, arches, wingwalls, and other associated elements (footings, headwalls, toewalls, baffles, etc.) or precast, prestressed concrete members.

612.02 Materials.

A. Provide Portland Cement Concrete in accordance with Section 1022 with a 28-day compressive strength as specified in the Contract Documents. For precast elements, if no strength is specified in the Contract Documents, provide concrete with a 28-day compressive strength of 5,000 pounds per square inch. For precast, prestressed elements, if no strength is specified in the Contract Documents, provide concrete with a 28-day compressive strength of 6,000 pounds per square inch and a compressive strength at time of initial release of 4,800 pounds per square inch.

B. Provide Bar Reinforcement in accordance with Sections 1037. For precast box Culverts 12 feet x 12 feet or smaller, provide reinforcing steel as per ASTM C1577.

C. Provide Prestressing Strands in accordance with Section 1038.

D. Provide galvanized angles and plates in accordance with Section 1039. Anchor studs are to be automatic end-welded.

E. Provide post-tensioning strands in accordance with Section 1038. Provide anchorages, fittings and couplings as shown in the Contract Documents and as per the manufacturer's recommendation.

F. Provide Closed-Cell Neoprene Sponge conforming to ASTM D1056, Type 2, Class D

G. Provide Joint Wrap conforming to ASTM C877

612.03 Construction.

A. Design

1. For precast box Culverts 12 feet x 12 feet or smaller, design as per ASTM C1577 – Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According the AASHTO LRFD.

2. For all other elements, design in accordance with the design Specification noted in the Contract Documents. Utilize AASHTO HL93 loading or Delaware Legal Load, whichever governs.

3. The soil bearing resistance will be as shown in the Contract Documents.

B. Working Drawings.

1. Submit Working Drawings for review and concurrence, consisting of a complete set of detailed shop drawings for the precast concrete units or prestressed concrete beams to be provided. Include the following, as applicable:

a. An overall plan showing all units together.

b. Details of each type of unit.

c. A plan view of reinforcement for any irregularly shaped sections (skewed, curved, etc.)

d. Details of placement of all embedded accessories such as threaded inserts, post-tensioning ducts, vents, weep holes, anchorage reinforcement and hardware, dowel holes, anchor bolts, shear connectors, tie rods, lifting strands or eyes, form hangers, stay-in-place form plates, and other related items. Ensure that there will be no conflicts among the planned positions of embedded items and that the concrete cover will be adequate.

e. Reinforcing bar list

f. Bill of Materials including all accessories

g. Method and sequence of post-tensioning

2. If the Contractor proposes an alternate design such as alternate structural dimensions or reinforcement, submit supporting calculations that meet the design criteria in Section 612.03.A. Submit load ratings for HL-93, HS-20, and Delaware legal loads using BRASS program in accordance with the latest version of the AASHTO *Manual for Bridge Evaluation*. The calculations will be certified by a registered Professional Engineer in the State of Delaware.

C. General Manufacturing Requirements

1. For precast elements, plants that are National Precast Concrete Association (NPCA)-certified and plants that have been inspected and approved by the Department, will be permitted to manufacture the units.

2. For prestressed elements, Precast/Prestressed Concrete Institute (PCI)-certified plants, and plants that have been inspected and approved by the Department, will be permitted to manufacture prestressed primary load carrying members.

3. All Materials, Equipment, processes of manufacture, and the finished units, as well as handling, storage, transportation, and erection, will be subject to inspection and approval. Any defective construction, which may adversely affect the strength of a member or its performance in the bridge Structure, will be cause for rejection.

4. Follow the manufacturer's recommended procedures for handling and placing the precast units during the entire process of transporting, unloading, and installing the members. Handle precast units only by lifting devices provided especially for this purpose.

D. Precast Concrete Elements

1. This section applies to precast concrete box Culverts, rigid frames, arches, wingwalls, and associated elements such as footings, headwalls, toewalls and baffles.

2. Precast Element Fabrication

a. Provide lifting devices as necessary. Placement of lifting devices must not come in conflict with prestressed strands. Show placement of lifting devices, material information, and details in Working Drawings.

b. Determine the section lengths and location of joints. Do not exceed a length that causes any bending, distortion, or stress being induced therein during lifting, moving, and placing of the section.

c. Joints

i. Provide neoprene gaskets at the joints between all precast units in order to make the joints watertight.

ii. For precast box Culverts, provide tongue and groove joints all around

iii. For precast rigid frames, provide shear keys all around

d. Provide shear keys at all wingwall-to-wingwall and structure-to-wingwall joints

e. Prepare for forming and pouring of the concrete in accordance with Section 610.

f. Provide reinforcement that meets or exceeds minimum area of steel per foot denoted in the Contract Documents or by ASTM C1577, as applicable.

i. Place bar reinforcement in accordance with Section 611. Place reinforcement beginning at 2 inches from the end of each unit.

ii. Where ASTM C1577 is applicable, provide clear cover as per ASTM C1577. Otherwise, provide minimum 2 inches clear cover.

g. Provide a smooth finish all around.

h. Cure precast concrete members that are manufactured in established plants with steam or radiant heat. Cure precast elements in accordance with ACI, PCI, or approved plant Quality Control Plans.

i. Provide a minimum of four post-tensioning ducts and tendons for box Culvert and rigid frames as indicated in the Contract Documents. Post-tensioning for precast arches will be in accordance with the manufacturer's recommendations.

j. Provide weep holes as indicated in the Contract Documents. Adjust actual locations of weep holes to maintain a 1 foot - 0 inch distance from any joint. Retain elevations as shown in the Contract Documents. Provide weep holes of 6 inch PVC pipe and with a 2 inch fall from back to front. Alternately, provide a 6 inch sleeve for field installation of weep holes.

k. Provide a maximum of four devices or holes in each unit for the purpose of handling.

l. Apply a water-miscible, penetrating, silane sealer to the top of each unit plus 2 feet – 0 inches down each side, and to all headwalls, end faces and exposed faces.

m. Tolerances

i. Internal Dimensions - The internal dimension will meet PCI MNL 135-0; 10.25.

ii. Slab and Wall Thickness – Any slab or wall thickness will not be more or less than the design dimensions by more than 5 percent.

iii. Length of Opposite Surfaces - Variations in laying lengths of two opposite surfaces of any unit sections will not be more than 1/8 inch per foot of internal span, with a maximum of 5/8 inch for all sizes through 7 feet internal span, and a maximum of 3/4 inch for internal spans greater than 7 feet.

iv. Length of Section - The variation in length will not be more than 1/8 inch per foot of length with a maximum of 1/2 inch in any unit.

v. Position of Reinforcement - The maximum variation in the position of the reinforcement will be ± 3/8 inch, except the cover over the reinforcement for the external surface of the top slab shall not be less than 2 inches for earth covers less than 3 feet, except where ASTM C1577 is applicable

vi. Area of Reinforcement - Steel areas greater than those required will not be cause for rejection. The permissible variation in diameter of any reinforcement shall conform to the tolerances prescribed in the ASTM specification for that type of reinforcement.

3. Precast Element Installation

a. Construct foundation consisting of a layer of the type of coarse aggregate as specified in the Contract Documents. Carefully place and tamp coarse aggregate to form a solid, unyielding mass with the exposed surface conforming to the form and dimensions shown in the Contract Documents. The bedding areas on which the coarse aggregate will be placed shall be approved by the Engineer prior to installation of the precast elements.

b. For box Culverts, place toewalls beneath the bottom slab at the inlet and outlet. Connect by dowels grouted into the bottom slab as shown in the Contract Documents. Place the 1 inch grout leveling pad immediately prior to placement of the Culvert. Contain in place, by Formwork or other acceptable means, the coarse aggregate beneath the Culvert while adjacent excavations (i.e., installation of wingwalls) are completed. Fill any voids between the bottom slab of the Culvert and the coarse aggregate with flowable fill prior to any backfilling. The filling of voids shall be at no additional cost to the Department.

c. Exercise care to insure proper matching and aligning of joints of adjacent units. Assemble precast units in accordance with the recommendations of the manufacturer and as approved by the Engineer in the field. Place the precast sections so that when they are laid together, they will make

a continuous line of units with a smooth interior free of appreciable irregularities. If necessary, shim units to maintain a difference of 1/2 inch or less between the soffits of adjacent units.

d. Post-tension precast elements such that neoprene gaskets are compressed all around and there is a 1/2 inch maximum gap between units. Maximum post-tensioning force will be 28,900 pounds. When post-tensioning is complete, the out-to-out dimension of the assembled units will be within ± 1 inch per 50 linear feet of precast structure and a ± 2 inch maximum. For rigid frame and arch Structures, ensure that the out-to-out dimension of the footing units matches the out-to-out dimension of the frame units.

e. Positively connect each wingwall-to-structure and wingwall-to-wingwall joint using bolted connections. Provide bolted connections consisting of a minimum of two 3 foot-0 inch wide x 2 foot - 0 inch tall x 1/4 inch thick plates per joint with at least four 3/4 inch bolts per plate. For angled plates, provide eight bolts. Slotted holes in the plate will not be permitted. Holes for anchor bolts may be field drilled. Where Structure and wingwall units do not form a proper joint after installation, repair with non-shrink grout or Class A concrete at no additional cost to the Department.

f. Prepare shear key surfaces to provide an exposed aggregate surface prior to leaving the plant. Utilize a non-shrinking, non-metallic grout having a minimum compressive strength at 28 days of 5,000 pounds per square inch to fill the shear keys. Before applying the grout, clean the surfaces of all dirt, dust, and other foreign matter. Wet the concrete surfaces prior to placement of grout. Do not allow any standing water to remain in the area to receive grout. During grout placement, prevent any falling material from reaching the roadway, waterway, or railroad area below. Prepare, place, and cure in accordance with the manufacturer's recommendations.

g. Cover the joint exterior with a minimum of a 9 inches wide wrap centered on the joint. Exercise care to keep the joint wrap in its proper location during backfilling.

h. Before backfilling, fill all post-tensioning pockets and ducts, lifting eyes, footing keyways, and any other holes or pockets with non-shrink grout. Cover all locations on the fill face with a minimum length and width of 9 inches of joint wrap Material.

i. Backfill equally on both sides of the precast Structure. At no point shall there be a difference in height of backfill of more than 1 foot. No construction Equipment or Materials, except for compaction Equipment, will be permitted to pass over or be placed on the precast units until the fill height has reached the bottom of the pavement subbase. Hauling of Materials over the precast Structure will be limited as directed, and in no case shall legal load limits specified in Section 105.12 of the Standard Specification be exceeded unless permitted in writing.

E. Prestressed Concrete Beam Elements. Follow the manufacturer's recommended procedures for handling and placing the precast units during the entire process of transporting, unloading, and installing the members. Handle precast units only by lifting devices provided especially for this purpose.

1. Section 612.03.E applies to precast, prestressed concrete load-carrying members such as voided slabs, box beams, bulb-T girders or NEXT beams.

2. Prestressed Element Fabrication

a. Provide lifting devices as necessary. Placement of lifting devices must not come in conflict with prestressed strands. Show placement of lifting devices, material information, and details in Working Drawings.

b. Provide beam dap details so that beams rest level on their bearing devices and non-bearing area details as necessary. Provide batter to make beam ends vertical when installed.

c. Provide a 1 inch deep recess around local strand groups with 2 inches minimum edge clearance and fill with pneumatically applied mortar immediately after clipping strands. An approved epoxy mortar covering the ends of strands with a minimum thickness of 1/8 inch may be used as an alternate.

d. Prepare for forming and pouring of the concrete in accordance with Section 610.

e. Place bar reinforcement in accordance with Section 611. Provide a minimum 2 inch clear cover unless noted otherwise in the Contract Documents. Adjust reinforcing bar spacing to clear all embedded accessories.

f. Provide threaded inserts at diaphragm connections or beams as specified in the Contract Documents. Threaded inserts must have a minimum ultimate pullout capacity of 11,900 pounds each. Threaded inserts and/or bar locations may be adjusted by 1/2 inch to avoid conflicts. Any deviations from this plan must be noted on the Working Drawings.

g. Provide appurtenances in prestressed beams as specified in the Contract Documents for later installation of stay-in-place forms or Falsework. Size, type, spacing, and location of these appurtenances will be determined by the stay-in-place form manufacturer.

h. Pre-tensioning

i. Bring all cables or strands to be pre-stressed in a group to a uniform initial tension of approximately 500 pounds per strand prior to being given their full pre-tensioning. Measure the stress using a dynamometer or other approved means so that the initial tension can be used as a check against elongations computed and measured. After this initial tensioning, stress the group of strands until the required elongation and jacking pressure is attained. Measure the stress induced in the cables or strands by jacking gages and by elongations of the cables or strands. The calculated stress based on the elongation should closely match the gage reading.

ii. Equip all jacks with accurate and calibrated gages for registering jacking pressures. Provide means for measuring the elongation of the pre-stressing strands to at least the nearest 1/32 inch. Furnish to the Engineer satisfactory, accredited proof that all jacking Equipment and gages to be used in the manufacture of the pre-stressed members have been calibrated by a reputable testing laboratory. The interpretations and analysis of the elongations and jacking pressures must consider and allow for all possible slippage or relaxation of the anchorage.

iii. If there is a discrepancy of as much as 10 percent between the stresses determined by the jacking pressure and the elongation measurement, carefully check the entire operation and determine the source of error before proceeding.

iv. After the cables or strands are stressed in accordance with the plan requirements and this Section and all other reinforcing is in place, place the concrete in the form. Only place concrete the temperature is between 50 and 85 degrees Fahrenheit. Maintain cable or strand stresses between anchorages until the concrete has reached a minimum compressive strength of 80 percent of the 28-day compressive strength and the process of transferring the pre-stress to the member has begun.

v. Immediately after the concrete attains initial set in accordance with AASHTO T197 steam cure members under a suitable enclosure to contain the live steam and minimize moisture and heat loss. The steam shall be at 100% relative humidity and cannot be discharged directly on the concrete or form. The temperature within the enclosure must increase at a rate no exceeding 40 degrees Fahrenheit per hour until a maximum temperature of 140 degrees Fahrenheit to 160 degrees Fahrenheit is reached. The maximum temperature must be maintained until the concrete has reached the specified release strength. After release strength is attained the temperature within the enclosure shall be gradually decreased at a rate not to exceed 40 degrees F per hour, until the temperature is no more than 30 degrees F above the ambient temperature. Curing temperatures must be recorded throughout the process.

vi. De-tension immediately following the curing period while the concrete is still warm and moist. Do not allow the concrete to dry and/or cool prior to de-tensioning. In all de-tensioning operations, keep the pre-stressing forces nearly symmetrical about the vertical axis of the member. De-tension in a manner that will minimize sudden or shock loading and limit the maximum eccentricity about the vertical axis to one strand. Remove or loosen forms, ties,

inserts, hold-downs, or other devices that would restrict longitudinal movement of the members along the bed during de-tensioning.

i. After completing the release of the pre-stresses, cut the strands flush with the ends of the member and paint with either an approved bitumastic compound or waterproofing compound.

j. Provide a heavy-scored finish on top of beams that will have a cast-in-place concrete deck constructed. Provide a smooth finish on top of beams to have a membrane and hot mix or warm mix riding surface applied.

k. Apply a clear water-miscible, penetrating, alkyl epoxy silane sealer to the bottom and sides of the finished beams.

l. Prestressed members may be handled immediately after curing and de-tensioning of the strands or cables. Do not ship members 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. Handle members using the pick-up points provided especially for this purpose. Maintain the members in a horizontal position (as when formed on the casting bed) at all times during handling, moving, storing, and shipping.

m. Permissible tolerances will be in accordance with those recommended by PCI.

3. Prestressed Concrete Element Installation

a. Install bearing devices in accordance with Section 623 and the details shown in the Contract Documents.

b. For adjacent beams, install connection devices; including, but not limited to, tie rods, shear connector plates, dowel bars, as shown in the Contract Documents. Place grout, in accordance with Section 612.03.D.3.f, or other shear key Material in shear keys and dowel holes as shown in the Contract Documents. No loads will be permitted on prestressed elements until the grout has cured.

c. For bulb-T beams, install intermediate diaphragms as shown in the Contract Documents.

612.04 Method of Measurement.

A. The quantity of precast box Culvert, precast rigid frame and precast retaining wall placed and accepted will be measured using plan quantities. For box Culverts, associated elements such as toewalls, headwalls and baffles will be measured as part of the box Culvert. For rigid frames, footings and headwalls will be measured as part of the rigid frame.

B. The quantity of precast concrete arch and precast concrete retaining wall for arches placed and accepted will not be measured.

C. The quantity of prestressed reinforced concrete members placed and accepted will not be measured.

612.05 Basis of Payment.

A. The Engineer will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
612000	PRECAST CONCRETE BOX CULVERT	CY
612001	PRECAST CONCRETE RIGID FRAME	CY
612002	PRECAST CONCRETE ARCH	LS
612010	PRECAST CONCRETE RETAINING WALL	CY
612011	PRECAST CONCRETE RETAINING WALL FOR ARCHES	LS
612020	PRESTRESSED REINFORCED CONCRETE MEMBERS, SOLID SLABS	LS

612021	PRESTRESSED REINFORCED CONCRETE MEMBERS, VOIDED SLABS	LS
612022	PRESTRESSED REINFORCED CONCRETE MEMBERS, BOX BEAMS	LS
612023	PRESTRESSED REINFORCED CONCRETE MEMBERS, BULB T BEAMS	LS
612024	PRESTRESSED REINFORCED CONCRETE MEMBERS, NEXT BEAMS	LS

B. Price and payment will constitute full compensation for furnishing all Materials, including reinforcing bar, related to the precast units; designing, fabricating and installing the units on site; and for all labor, tools, Equipment and incidentals required to complete the Work. Accessories and associated elements will be incidental to the respective Item. Excavation, backfill, backfilling, and coarse aggregate will be paid separately under their respective Bid Items**.**

C. The removal and replacement of all precast members rejected due to defective construction or improper storing, handling, transporting, or installation will not be paid.

SECTION 613 – CONCRETE COATINGS AND MEMBRANES

613.01 Description.

Furnish and apply the systems of coatings including waterproofing for concrete Structures.

613.02 Materials. Provide Materials as specified in:

Epoxy concrete sealer	Section 1045.01
Silicone-based acrylic concrete	Section 1045.02
Silane-based concrete sealer	Section 1045.03
High-molecular-weight methacrylate concrete sealer	Section 1045.04
Waterproofing membrane	Section 1045.05

613.03 Construction.

A. Pre-Installation

1. Arrange for a manufacturer's representative to be present during the surface preparation and application of the coating, as directed by the Engineer. A manufacturer's letter of certification as an approved installer may also be accepted in lieu of having a manufacturer's representative onsite.
2. Supply a Materials Safety Data Sheet (MSDS) and a letter of certificate compliance of batch and lot of each shipment of the concrete sealer Materials. Also, provide a manufacturer analysis report of the Materials used with the specified batch shipped to the job site.
3. Provide manufacturer's instructions for the installation of the system at least two weeks prior to beginning the surface preparation.

B. Surface Preparation

1. Complete all new concrete surfaces, texturing, saw cutting, grooving, and repointing before preparing the surface for sealer. Cure all concrete that is to be sealed at least 28 days or for the length of time specified in the manufacturer's instruction.
2. Completely remove all curing compound prior to the application of the coating. Use a sandblast or shot-blast, followed by vacuum cleaning in accordance with ASTM D4258 and SSPC-SP-13, unless the curing compound is deemed compatible by the manufacturer's recommendations.
3. Remove all loose material, grease, dirt, salt, efflorescence, laitance, and other foreign matter in accordance with ASTM D4258. For existing concrete surfaces, removal also includes all previous sealers and paints.
4. In addition, high-pressure-wash both new and existing concrete with water at a flow of more than 4 gallons per minute, with zero degree of rotary nozzle. Allow the surface to dry for a minimum of 24 hours prior to the coating application after high-pressure washing or a rain event. Surface must be completely dry before beginning applications. Repair any damage done to the concrete surface as a result of high-pressure wash at no cost to the Department.
5. Immediately prior to application, blow the surface area clean with oil-free compressed air.
6. Apply coatings and membranes when the surface and ambient temperature are between 40 degrees Fahrenheit and 85 degrees Fahrenheit and are forecast to remain in that window until the system has set up. If the manufacturer's recommended temperature range is more stringent, the manufacturer's requirements shall govern.
7. Do not begin applying coating until all surface preparation Work is complete and has been approved by the Engineer.

C. Epoxy Sealer

1. Apply the sealer as supplied by the manufacturer without thinning or alteration, unless specifically required in the manufacturer's instructions and verified by the Engineer.

2. Apply the sealer Material using the coverage rate and Equipment in accordance with the manufacturer's recommendations.

3. Follow the manufacturer's recommendation for coating thickness. No drips, runs, or sags will be allowed during application.

4. Broadcast oven-dried fine aggregate on the surface after applying the epoxy Material. Brush off excess fine aggregate after the epoxy coating has dried.

D. Silicone and Silane Sealers

1. Apply the sealer as supplied by the manufacturer without thinning or alteration, unless specifically required in the manufacturer's instructions and verified by Engineer.

2. Apply the sealer Material using the coverage rate and Equipment in accordance with the manufacturer's recommendations. A minimum of two coats must be applied. Follow the manufacturer's recommendations for drying times between coats.

   a. For the silane sealer, identify an area equal to 125 square feet and measure the amount applied through the sprayer. If less than one gallon of Material is used, adjust the method of application. Calculate the yield for each day and submit to the Engineer. If the yield for any day exceeds 125 square feet per gallon, then recoat the entire area for that day at a rate of 175 square feet per gallon.

3. Perform all applications under dry conditions with application-spread rate as recommended by the manufacturer. Apply the sealer within the ambient temperature range as recommended by the manufacturer, when no rain is expected within a minimum of 12 hours following the application, and there are no high winds that would cause an improper or uneven application.

4. Follow the manufacturer's recommendation for coating thickness. No drips, runs, or sags will be allowed during application. A natural-bristle brush, roller, or spray may be used to perform the application.

5. Perform surface preparation and application of the concrete sealer Material so as not to endanger any private and/or public property, pedestrians, workmen, and vehicles on, beneath, or adjacent to the Structure.

6. Allow silicone-based acrylic sealer to dry one week before testing adhesion per ASTM D7234.

7. Do not allow traffic on the treated surface until the waterproofing solution has been completely absorbed and the surface is dry in accordance with the manufacturer's recommendations.

E. Methacrylate Sealer

1. Become aware of and follow the manufacturer's safety precautions of all Materials and exercise appropriate measures. Equipment used for cleaning and preparing the surface areas and for the application of the crack sealer is subject to approval prior to their use. Store Materials in accordance with the manufacturer's recommendations. Applicable fire codes may require special storage facilities for some components of the system.

2. Prior to the application of the crack sealing Material, clean the concrete surfaces in accordance with the manufacturer's recommendations. This will involve removal of all traces of dust, dirt, salt, grease, oil, curing compounds, waxes, asphalt, laitance, and all other foreign contaminants. Ensure that the substrate is clean, sound, and free of surface moisture prior to application. Closely monitor the surface preparation to avoid any unnecessary surface damage. Surface preparation is subject to final approval by the Engineer.

3. Apply the crack sealing Material without thinning or alteration and within the ambient temperature

range as recommended by the manufacturer, when no rain is expected within a minimum of two hours following the application, and when there are no high winds that would cause an improper or uneven application. If rain has preceded the application, allow the surface to dry at least 24 hours before the application of the crack sealer begins.

4. If excess sealing Material is on the surface after the crack sealing treatment has been completed, cover the area with a light broadcast of a dry sand meeting the requirements of Section 1003. Use only an amount of sand that is sufficient to absorb the excess Material. The time of sand broadcast shall be in accordance with the manufacturer's recommendation.

5. Keep traffic off the treated surface until the crack sealing Material has been completely absorbed and the surface is dry in accordance with the manufacturer's recommendation.

6. Perform surface preparation and application of the crack sealing Material so as not to endanger any private and/or public property, pedestrians, workmen, marine traffic, and vehicles on, beneath, or adjacent to the Structure.

F. Waterproofing Membranes

1. Install the membrane in accordance with the manufacturer's recommendations.

2. If the existing deck was overlaid with hot mix or asphaltic concrete, remove the overlay in its entirety by milling or by the recommended method. Payment for removal will be made under the respective pay Item.

3. Patch all holes or voids in the concrete deck with an approved non-shrink grout, and remove all sharp protrusions. Broom and thoroughly clean the deck surface such that there is no presence of dirt, loose concrete, nor other contaminates. The cleanliness may require lightly shot-blasting and vacuuming.

4. Prior to installing the membrane, apply primer to the cleaned deck and up the curb face to the height required for the membrane. Apply the primer as thin as possible by brush, squeegee, or roller. Brush out any puddles and allow the primer to dry to touch as per the manufacturer's recommendation.

5. Install the membrane at an ambient temperature of 50 degrees Fahrenheit or higher as per the manufacturer's requirement.

6. Apply the membrane by hand-rolling the laminates onto the primed surface or by using approved mechanical aids. In either case, remove the release paper as the installation of the membrane proceeds. The membrane must cover the deck with the sticky side down.

7. Roll the membrane into close contact with the deck surface with a segmented rubber-tired roller or a lawn roller. Roll the membrane into close contact with the vertical concrete surfaces using a carpet-padded wooden float.

8. Overlap the membrane sheets by at least 3 inches or as specified by the manufacturer. Stagger membrane overlaps in the transverse direction.

9. Seal the overlaps at the end of each roll and bond the membrane to the curb by heating with a propane torch. Eliminate all entrapped air bubbles by puncturing the membrane and patching.

10. Place a tack coat on the membrane prior to application of the overlay.

11. Place the bituminous overlay when the temperature is between 290 degrees Fahrenheit and 340 degrees Fahrenheit or as per the manufacturer's recommendation.

613.04 Method of Measurement.

A. The quantity of concrete coatings will be measured as the actual number of square feet of concrete surface area coated and accepted. Multiple coats will not be measured more than once.

B. For precast concrete elements, the quantity of silane sealer will not be measured.

613.05 Basis of Payment.

A. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
613000	EPOXY CONCRETE SEALER	SF
613001	SILICONE-BASED ACRYLIC CONCRETE SEALER	SF
613002	SILANE-BASED CONCRETE DECK SEALER	SF
613003	HIGH MOLECULAR WEIGHT METHACRYLATE CONCRETE SEALER	SF
613004	WATERPROOFING MEMBRANE, TRAFFIC BEARING	SF
613005	WATERPROOFING MEMBRANE, NON-TRAFFIC BEARING	SF

B. Price and payment for concrete coatings will constitute full compensation for the technical representative, furnishing all Materials, furnishing and removing scaffolding as required, surface preparation, application of the coating Material, disposal of discarded Materials, any recoating due to low application rates, and for all labor, tools, Equipment, and all necessary incidentals to complete the Work.

SECTION 615 – STEEL STRUCTURES

615.01 Description.

Furnish, fabricate, and erect steel Structures and structural steel elements of other Structures.

615.02 Materials.

A. Provide Materials as specified in:

Anchor Bolts	Section 1039.04
Bearing Materials	Section 623
Coatings	Section 616
Fasteners	Section 1039.02, 1039.03
Forgings and Castings	Section 1039.06, 1039.07
Galvanizing	Section 1039.10
Pipe and Tubing	Section 1039.08
Shear Connectors	Section 1039.05
Sheet Zinc and Copper	Section 1039.09
Structural Steel	Section 1039.01

615.03 Construction.

A. *Documentation*:

1. *Certification.* Structural steel and aluminum fabricators performing Work for the Department are required to prequalify according to the American Institute of Steel Construction's (AISC) Quality Certification Program as follows:

   a. *Simple Bridge.* Unspliced rolled sections and pedestrian bridges.

   b. *Intermediate Bridge.* A rolled-beam bridge with field or shop slices, either straight or with a radius over 500 feet; a built-up I-shaped plate girder bridge with constant web depth (except for dapped ends), with or without splices, either straight or with a radius over 500 feet; a built-up I-shaped plate girder with variable web depth (e.g., haunched) either straight or with a radius over 1000 feet; a truss bridge with a length of 200 feet or less that is entirely or substantially preassembled at the certified facility and shipped in no more than three subassemblies.

   c. *Advanced Bridge.* Tub or trapezoidal box girders, closed boxed girders, large or non-preassembled truss Bridges, arches, cable-supported Bridges, movable Bridges, and Bridges with curved radii tighter than those defined for Intermediate Bridge.

   d. *Highway Metal Components, including Aluminum.* Fence Materials, guardrails, handrails, reinforcing steel (rebar), casing pipes, metal drainage items, stay-in-place forms, light poles, high-mast poles, metal buildings, steel strain poles, bridge rail, stairs, walkways, grid decks, scuppers, expansion joints, bearings, ballast plates, complex expansion joints, high-load, multi-rotational bearings, bracing not designed for primary loads (diaphragms, cross frames, and lateral bracing), movable bridge machinery, and sign or signal Structures erected partially or completely over the traveled roadway or mounted on Bridges.

   An AISC Fracture-Critical Endorsement is required for all fracture-critical work.

2. *Notice of Beginning of Work*. Provide written notice and source of supply thirty Days before Work begins at the mill or shop. Begin Work only after receiving notice back from the Department.

3. *Inspection*. Furnish copies of all mill orders and certified mill test reports. Include the chemical analysis and physical test results for each heat of steel used in the Work. The Engineer may accept certificates of compliance in place of mill test reports for material normally not supplied with mill test reports, and for Items in small quantities taken from stock.

   Include the Charpy V-notch impact test results in certified mill test reports for steels with specified impact values. For specified fine grain practice, include in the test report confirmation that the Material was produced using the practice. Furnish copies of mill orders at the time the order is placed. Furnish certified mill test reports and certificates of compliance before beginning fabrication. Ensure the certificate of compliance carries the manufacturer's signature and that the Material meets Specifications.

4. Make Material available for inspection by the Engineer at the fabrication site. Provide free access at all times to any portion of the fabrication site.

5. *Quality Control Plan***:** Submit a Contractor Quality Control Plan to verify that all Materials and workmanship meet the requirements of the Contract Documents.

   Do not commence Work until the Contractor Quality Control Plan is approved. Provide sufficient detail in the plan to enable the Engineer to determine the adequacy of the plan. As a minimum, provide the following information in the plan:

   a. Name, address, and facility or site number of the fabricator.

   b. A description of the fabricator's organization, including the following;

      i. Clearly established lines of authority and position titles.

      ii. List of personnel showing their experience and qualifications.

      iii. Position, title, and name of the individual assigned to the position.

      iv. A list of function and duties assigned to the position.

      v. Organizational Chart.

      vi. The fabricator's AISC Certifications, indicating the facility's appropriate certification levels for all work to be performed, and AISC-approved Quality System Documentation.

      vii. A statement signed by management affirming the fabricator's commitment to achieving a quality product and implementation of this commitment through all personnel.

      viii. A detailed description of the responsibilities of the Quality Control Department.

   c. A description of the Contractor procedures that will ensure quality Materials and workmanship, clearly addressing the methods used, frequency of inspections or tests, and personnel responsible as appropriate. Include forms or other documents as well. Include procedures that explain how the following tasks will be performed that ensure compliance with the requirements of the Contract Documents:

      i. Material traceability;

      ii. Hot and/or cold bending;

      iii. Cambering and heat-curving, including temperature measurement, patterns, and sequences, and supporting or loading positions with copies of the design computations if other than restraining forces are applied;

      iv. Shop assembly/laydown, including drilling and/or punching;

      v. Post-heat and/or stress-relieving procedures;

      vi. Heat-straightening;

vii. Installation of high-strength bolts and rotational capacity (RC) tests; and Direct Tension Indicator (DTI) Verification tests

viii. Field welding;

ix. Blast-cleaning, painting, galvanizing, and/or other applied coatings;

x. Use of ASTM A490 bolts;

xi. Removal of lubricants from exposed surfaces of installed fastener assemblies.

B. *Working Drawings*.

1. *Fabrication Drawings.* Submit copies of detailed fabrication drawings for approval in accordance with the review times stipulated in Section 105.04 before starting the Work to allow time for review by the Engineer and revisions by the Contractor.

   Ensure fabrication drawings fully detail dimensions and sizes of structure components and associated parts.

   Where specific orientation of plates is required, show the direction of rolling of plates.

   Identify on fabrication drawings each piece made of steel that is not AASHTO M 270, Grade 36 steel.

   Furnish a fabricator-prepared diagram showing the camber and sweep at each panel point for trusses or arch ribs, at field splices, and fractions of span length (tenth points minimum) for continuous beam and girders or rigid frames. Include calculated cambers and sweeps to be used in the Structure's preassembly.

   Include fabrication methods in the written weldment procedure specifications of the Working Drawings.

   Do not begin fabrication before the Working Drawings are approved by the Engineer per Section 105.04.

2. *Erection Drawings*. Submit drawings that completely illustrate the proposed method of erection. Show details of Falsework bents, bracing, guys, dead-men, lifting devices, and attachments to the Bridge members. Show erection sequence, location of cranes and barges, crane capacities, location of lifting points on the Bridge members, and weights of the members. Coordinate erection plans with Maintenance of Traffic Plans. Ensure the drawings completely detail all anticipated phases and conditions during erection. Furnish calculations showing that factored resistances are not exceeded and that member capacities and final geometry will be correct. Provide method of verification for the proper alignment and camber of the Structure.

C. Fabrication:

1. *Identifying Steel During Fabrication*. Use a system of assembly, marking individual pieces and providing cutting instructions to the shop that maintains the identity of the original piece.

   The Contractor may furnish Material taken from stock that is identifiable by heat number and mill test reports, with the Engineer's approval.

   During fabrication, up to the point of assembling members, ensure that each member, excluding those of Grade 36 steel, clearly displays its Specification. Acceptable markings include writing the grade on each piece or using the identification color code specified in Table 615.03-1.

Table 615.03-1. Identification Color Codes

Grade	Color Code
50	Green and yellow
50W	Blue and yellow

70W	Blue and orange
100	Red
100W	Red and orange

For metals other than Grade 36 steel that are not included in either Table 615.03-1. or in ASTM A6, provide information on the color code used.

Ensure steel pieces are grade-marked by low-stress-type steel die-stamping or by a firmly attached tag. Exclude Grade 36 steel from this requirement because it is subject to blast-cleaning, galvanizing, heating for forming, or painting that might obliterate the color-code markings before assembling into members.

Furnish an affidavit certifying the steel identification was maintained throughout fabrication, if requested.

2. *Storing Materials*. Store structural steel, plain or fabricated, above the ground on platforms, skids, or other supports. Keep steel free from dirt, grease, and other foreign matter, and protect it from corrosion. Store high-strength fasteners as specified in Section 615.03.D.6.c.i.

3. *Plates:*

   a. *Direction of Rolling*. Cut and fabricate steel plates for main members, and splice plates for flanges and main tension members, so the primary direction of rolling is parallel to the main tensile and/or compressive stresses.

   b. *Plate-Cut Edges*. Plane, mill, grind, or thermal-cut to a depth of 1/4 inch the sheared edges of plates more than 5/8 inch thick that carry calculated stress.

      i. *Oxygen Cutting*. For oxygen cutting, meet *AASHTO/AWS D1.5 Bridge Welding Code.*

      ii. *Visual Inspection and Repair of Plate-Cut Edges.* For visual inspection and repair of plate-cut edges, meet *AASHTO/AWS D1.5 Bridge Welding Code.*

   c. *Bent Plates*. Take plates to be bent from the stock plates to ensure the bend line is at right angles to the direction of rolling. Cold-bent ribs for orthotropic deck bridges may be bent with the bend lines in the direction of rolling only with prior approval. Before bending, round the plate corners to a 1/16 inch radius where the bend will be placed.

      i. *Cold Bending*. Cold bend steel without cracking the plate. Use the minimum bend radii specified in Table 615.03-2., measured to the concave face of the metal.

Table 615.03-2. Minimum Bend Radii

Plate Thickness, *t* (in.)	Bending Radius (for all grades of structural steel)
Less than 1/2	2*t*
Over 1/2 to 1	2.5*t*
Over 1 to 1-1/2	3*t*
Over 1-1/2 to 2-1/2	3.5*t*

      ii. *Hot Bending*. Hot-bend radii smaller than the minimum specified for cold-bending with the plates at a temperature less than 1,200 degrees Fahrenheit, excluding AASHTO M 270, Grades 70W, 100, and 100W steel. Re-quench and temper Grades 100 and 100W steel when the steel to be bent is to be heated higher than 1,100 degrees Fahrenheit.

4. *Fit of Stiffeners*. Mill or grind end-bearing stiffener for girders and stiffeners supporting concentrated loads to bear (either milled, ground, or on weldable steel in compression areas of flanges, welded as

specified) at the flange. Ensure intermediate stiffeners that do not support concentrated loads fit tightly against the compression flange.

5. *Abutting Joints*. Mill or saw cut abutting ends in compression members of trusses and columns to provide a square joint and uniform bearing. The maximum opening in unfaced joints is 3/8 inch.

6. *Facing Bearing Surfaces*. Ensure the surface finish for bearing, base plates, and other bearing surfaces that contact each other or concrete meet ASME B46.1, as specified in Table 615.03-3.

Table 615.03-3. ANSI Surface Roughness Values

Bearing Surface	Surface Roughness Value in. × 10^{-6}
Steel slabs	2000
Heavy plates in contact in shoes to be welded	1000
Milled ends of compression members, milled or ground ends of stiffeners and fillers	500
Bridge rollers and rockers	250
Pins and pin holes	125
Sliding bearings	125

7. *Member Geometry***.**

   a. *Tolerances***.** Provide dimensional tolerances as follows:

      i. Rolled shapes, plates, bars, wide-flange sections, and miscellaneous steel in accordance with ASTM A6;

      ii. Fabricate girders in accordance with the AASHTO/AWS D1.5, Bridge Welding Code and as described below;

      iii. Tolerances for camber and sweep of continuous and simply supported girders of any shape shall be as described in the AASHTO/AWS D1.5, Bridge Welding Code. The camber and sweep tolerances for steel pier caps shall be the same as those specified for girders. Measure sweep for horizontally curved members from the theoretical centerline for comparison to the aforementioned requirements. Allowances must be made in the shop for shrinkage due to welding and burning. If uneven shrinkage is anticipated, adjust camber ordinates accordingly.

   b. *Alternate Sections*. Rolled sections or fabricated sections of equal or slightly greater dimensions than the section specified may be proposed for the Engineer's approval. Changes that reduce fatigue resistance or significantly affect the splice design or deflection will require complete design calculations.

   c. *Web Flatness*. Maximum deviation from flatness for webs of curved and/or cambered sections shall be the same as for straight, built-up girders. Measure curved girder web flatness using a straightedge oriented perpendicular to the flanges ('vertical', flange-to-flange).

   d. *Girder Length*. If measuring girder length with a device that is free of thermal effects, appropriately adjust the measurements to the reference temperature shown in the Contract Documents. Measure the length of horizontally curved girders along the arc.

8. *Straightening Material*. Straighten plates, angles, other shapes, and built-up members without fracturing or damaging the metal. Use mechanical means to straighten distorted members by applying limited, localized heat. Perform heat-straightening of AASHTO M 270 Grades 70W, 100, and 100W steel members only under rigidly controlled conditions subject to approval. Do not exceed the temperature values specified in Table 615.03-4.

Table 615.03-4. Maximum Straightening Temperature (U.S. Customary Units)

Material to Be Straightened	Maximum Temperature (°F)
Grade 70W > 6 in. from weld	1,050
Grade 70W < 6 in. from weld	900
Grade 100 and 100W > 6 in. from weld	1,100
Grade 100 and 100W < 6 in. from weld	950

The maximum straightening temperature for all other steels is 1,200 degrees Fahrenheit. Measure temperature using temperature-indicating crayons, liquids, or bimetal thermometers. The Engineer will reject Material heated in excess of the specified limits unless testing verifies Material integrity.

Ensure parts to be heat-straightened are free of stress and external forces, including stresses from mechanical means used to apply the heat.

All straightened pieces showing evidence of fracture will be rejected by the Engineer.

9. *Finish***.** Finish exposed Work. Shear, flame-cut, and chip carefully and accurately. Make sharp corners and round edges by grinding or other acceptable means.

10. *Bolt Holes for High-strength Bolts and Unfinished Bolts:*

    a. Punch or drill bolt holes as follows:

        i. Either sub-drill and ream or drill full-size holes. Standard hole size is bolt diameter plus 1/16 inch. Meet requirements of Section 615.03.C.10.g.

        ii. For members composed of not more than five thicknesses of metal, the Contractor may punch bolt holes full-size, provided the thickness of the Material is not greater than 3/4 inch for structural steel, 5/8 inch for high-strength structural steel, and 1/2 inch for quenched and tempered alloy steel.

        iii. When specified, sub-punch or sub-drill all holes (sub-drill if thickness limitation governs) 1/4 inch smaller. After assembling, ream or drill to full size.

        iv. When specified, the Contractor may use enlarged or slotted holes for high-strength bolts.

    b. *Punched Holes*. For punched holes, ensure that the die diameter does not exceed the punch diameter by more than 1/16 inch. Ream undersized holes. Ensure holes are clean-cut, without torn or ragged edges.

    c. *Reamed or Drilled Holes*. Ream or drill holes perpendicular to the member to meet the above size requirements. Where practical, use mechanically directed reamers. Remove burrs on the outside surfaces. Ream and drill using twist drills, twist reamers, or rotobroach cutters. Assemble and securely hold connecting members while reaming or drilling holes. Match-mark before disassembling.

    d. *Tolerance of Holes*. Acceptable holes are those not more than 1/32 inch larger in diameter than the decimal equivalent of the minimal diameter resulting from the drill or reamer. Ensure the slotted-hole width produced by flame-cutting or a combination of drilling or punching and flame-cutting is no more than 1/32 inch larger than the nominal width. Grind the flame-cut surface smooth.

e. Tolerance of Hole Group:

i. *Before Reaming*. Punch full-sized, sub-punched, or sub-drilled holes so that, after assembling (before any reaming is done), a cylindrical pin, 1/8 inch smaller in diameter than the nominal size of the punched hole, may be inserted into the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. The Engineer will reject pieces not meeting this requirement. The Engineer will also reject holes not large enough to pass a pin that is 1/4 inch smaller than the nominal size of the punched hole.

ii. *Tolerance After Reaming.* Ensure that when holes are reamed or drilled, 85 percent of the holes in any contiguous group show no offset greater than 1/32 inch between adjacent pieces.

Use steel templates that have hardened steel bushings in the holes and that are accurately dimensioned from the connecting centerlines as inscribed on the template. Use the centerlines to locate the template from the milled or scribed ends of the members.

f. *Holes for Ribbed Bolts, Turned Bolts, or Other Approved Bearing-Type Bolts*. For ribbed bolts, turned bolts, or other approved bearing-type bolts, sub-punch or sub-drill holes 3/16 inch smaller than the nominal bolt diameter. Ream when assembled, or drill using a steel template or, once assembled, drill from the solid to ensure the finished holes provide a driving fit.

g. *Preparing Field Connections*. Sub-punch or sub-drill holes in all field connections and field splices of main truss members, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames. Ream holes with Material assembled or drill full-size through a steel template once assembled. Holes for field splices of rolled beam stringers continuous over floor beams or cross frames and all holes for floor beams may be drilled full-size unassembled to a steel template.

Sub-punch and ream holes for floor beam and stringer field end connections while assembled, or drill full-size to a steel template. Locate steel template before reaming and drilling. Use exact duplicates of templates for reaming matching members or the opposite faces of a single member. Locate templates used for connections on similar parts or members so match-marking is not required.

The Engineer may allow full-size drilling of holes instead of sub-punching and reaming or sub-drilling and reaming for all thicknesses.

11. *Heat-Curving*. Flanges of curved, welded girders may be cut to the radii specified or curved by applying heat.

a. *Minimum Radius for Heat-Curving*. Heat-curving of beams and girders is allowed when the horizontal radius of curvature measured to the centerline of the member web is greater than both values calculated by Equations 1 and 2 below, and greater than 150 feet at any and all cross sections throughout the length of the member. Do not heat-curve steels manufactured to a yield strength greater than 50 kips per square inch, other than AASHTO M270, Grade HPS 70W.

$$R = \frac{14bD}{\sqrt{F_y \psi t}} \text{ in.} \quad \text{(Equation 1)}$$

$$R = \frac{7500b}{F_y \psi} \text{ in.} \quad \text{(Equation 2)}$$

where:

Fy = specified minimum yield point of member web, ksi;

ψ = ratio of the total cross section area to the cross-sectional area of both flanges;

b = width of the widest flange, inch;

D = clear distance between flanges, inch;

t = web thickness, inch;

R = radius, inch.

In addition to the above requirements, do not heat-curve if the radius is less than 1,000 feet when the flange thickness exceeds 3 inches or the flange width exceeds 30 inches.

b. *Type of Heating*. Curve beams and girders by either continuous or V-type heating. For the continuous method, heat a strip or intermittent strips along the edge of the top and bottom flange simultaneously. Ensure the strip has sufficient width and temperature to obtain the required curvature.

For V-type heating, heat the top and bottom flanges in truncated triangular or wedge-shaped areas having their base along the flange edge and spaced at regular intervals along each flange. Ensure the spacing and temperature are sufficient to obtain the required curvature. Heat along the top and bottom flange at the same rate. Terminate the apex of the truncated triangular area applied to the inside flange surface before the juncture of the web and the flange is reached. Avoid applying heat directly to the web. When the radius of curvature is 1,000 feet or more, extend the apex of the heating pattern applied to the outside flange surface to the juncture of the flange and web. When the radius of curvature is less than 1,000 feet, extend the apex of the heating pattern applied to the outside flange surface past the web for a distance equal to one eighth of the flange width or 3 inches, whichever is less. Size the pattern with an included angle of approximately 15 to 30 degrees, and a base less than 10 inches. Obtain approval to vary the pattern.

For both heating methods, heat the flange edges that will be on the inside of the horizontal curve. Heat both inside and outside flange surfaces concurrently when the flange thickness is 1-1/4 inches or greater.

c. *Temperature*. Conduct heat-curving operations at temperatures less than 1,150 degrees Fahrenheit. Do not artificially cool the girder until it has naturally cooled to 600 degrees Fahrenheit. Obtain approval for the method of artificial cooling.

d. *Position for Heating*. Heat-curve the girder with the web in either a vertical or a horizontal position. When curved in the vertical position, brace or support the girder to prevent lateral deflection and keep the girder from overturning.

When curved in the horizontal position, support the girder near its ends and at intermediate points to obtain a uniform curvature. Ensure the bending stress in the flanges caused by the dead load of the girder and externally applied loads remains within the allowable design stress. When the girder is positioned horizontally for heating, maintain intermediate safety catch blocks at the mid-length of the girder within 2 inches of the flanges at all times during the heating process to guard against a sudden sag resulting from plastic flange buckling.

12. *Cleaning and Coating*: Clean and coat the work in accordance with Section 616.

13. *Shop Splices*: Locate all shop web splices a minimum of 12 inches from shop flange splices and connection plates for cross frames. Flange and web shop splices must be completed and weldments inspected before fitting and welding flanges to webs.

D. *Assembly:*

1. *Bolting*. For bolted connections, clean metal contact surfaces before assembling. Assemble the member before drilling, reaming, or bolting. Remove all burrs and shavings and ensure the member is free from twists, bends, and other deformations.

When assembling, allow enough drifting to bring the parts into position, however, do not allow the drifting to enlarge the holes or distort the metal.

Install bolts with bolt heads on the bottom of bottom flanges and the exterior face of exterior girders.

2. *Welded Connections*. Ensure that surfaces and edges to be welded are smooth, uniform, clean, and free of defects. Prepare edges according to *AASHTO/AWS D1.5 Bridge Welding Code*.

3. *Preassembly of Field Connections*. Preassemble field connections of main members of trusses, arches, continuous beams, plate girders, bents, towers, and rigid frames prior to erection as necessary to verify the geometry of the completed Structure or unit and to verify or prepare field splices. Submit the method and details of preassembly for approval by the Engineer. Use methods and details of assembly that are consistent with the erection procedure shown on the approved erection plans and camber diagrams.

   Preassemble at least three contiguous panels or sections that are accurately adjusted for line and camber. For successive assemblies, include at least one section or panel of the previous assembly (repositioned if necessary and adequately pinned to ensure accurate alignment), plus two or more sections or panels added at the advancing end. In the case of Structures longer than 150 feet, make each assembly not less than 151 feet long regardless of the length of individual continuous panels or sections. The sequence of assembly may start from any location in the Structure and proceed in one or both directions, provided the preceding requirements are satisfied.

   Use the Progressive Truss and Girder Assembly, unless specified otherwise.

   a. Bolted Connections. Prepare holes for bolted connections as specified in Section 615.03.C.10. Where applicable, assemble major components with milled ends of compression members in full bearing and then ream their sub-sized holes to the specified size while the connections are assembled.

   b. *Field-Welded Connections*. Prepare or verify the fit of members including the proper space between abutting flanges, with the segment preassembled, before performing a field-welded connection.

4. *Match-Marking*. Match-mark connecting parts preassembled in the shop to ensure proper fit in the field. Provide a diagram that shows such marks.

5. *Connections Using Unfinished or Turned Bolts*. When specified, furnish unfinished or turned bolts conforming to ASTM A307, Grade A Bolts. Provide bolts with single, self-locking nuts or double nuts, unless otherwise specified. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. The specifications of this section do not pertain to the use of high-strength bolts, which are addressed in Section 615.03.D.6.

   a. *Unfinished Bolts*. Furnish unfinished bolts unless otherwise specified.

   b. *Turned Bolts*. Provide turned bolts with an ANSI roughness rating value of 125 for the surface of the body of the bolts. Ream turned bolt holes and turn the bolt to a driving fit with the threads entirely outside of the holes. Use hexagonal-headed bolts and nuts and provide washers.

6. *Connections Using High-Strength Bolts*. For connections using high-strength bolts, use ASTM A325 or ASTM A490 high-strength bolts, or equivalent fasteners, installed to develop the minimum required bolt tension specified in Table 615.03-5. Install bolts in holes formed as specified in Section 615.03.C.10. When Turn-of-Nut Tightening Method is used, provide hardened washers under the element turned in tightening.

   a. *Bolted Parts*. Use steel for all Material within the grip of the bolt. Do not use compressible Material such as gaskets or insulation within the grip. Ensure that bolted steel parts fit solidly together after the bolts are tightened. Limit the maximum slope to 1:20 for the surface parts in contact with the bolt head or nut with respect to a plane normal to the bolt axis.

   b. *Surface Conditions*. At the time of assembly, ensure that all joint surfaces, including surfaces adjacent to the bolt head and nut, are free of scale, except tight mill scale, and free of dirt or other foreign material. Remove burrs and any other material that would prevent solid seating of the connected parts in the snug condition.

      Paint the faying surface, except in slip-critical joints, as designated in the *AASHTO LRFD Bridge Design Specifications*.

      Meet the following requirements, as applicable, for the faying surfaces of slip-critical connections:

i. *Uncoated Joints*. For uncoated joints, exclude paint, including any inadvertent overspray, from areas closer than one bolt diameter, but not less than 1 inch, from the edge of any hole and all areas within the bolt pattern.

ii. *Joints with Painted Faying Surfaces*. For joints with painted faying surfaces, blast-clean and coat with a paint qualified under *AASHTO LRFD Bridge Design Specifications*.

iii. *Coated Joints*. For coated joints, assemble after the coating has cured for the minimum time used in the qualifying test.

c. *Installation*:

i. *Fastener Assemblies*. Hot-dip faying surfaces to be galvanized according to AASHTO M 111. Roughen by hand-wire-brushing. Do not use power wire-brushing. Assemble and assign lot numbers prior to shipping. Protect from dirt and moisture at the job site. Remove from protective storage only the number of anticipated assemblies to be installed and tensioned during a work shift. Return unused assemblies to protected storage at the end of the shift. Do not clean assemblies of lubricant that is required to be present in the as-delivered condition. Clean assemblies for slip-critical connections that accumulate rust or dirt resulting from job site conditions. Clean, re-lubricate, and test for rotational capacity prior to installation. Lubricate galvanized nuts with a lubricator containing a visible dye. Ensure plain bolts are “oily” to touch when delivered and installed. Remove lubricant on exposed surfaces before painting.

ii. *Load Indicator Devices.* Provide a bolt-tension measuring device, meeting ASTM F 959, at the job site to perform the rotational capacity test and to confirm the ability to satisfy the requirements of Table 615.03-5. If approved, the Contractor may use alternative design direct tension indicating devices provided they meet the above requirements or approved manufacturer specifications.

iii. *Calibrating Wrenches*. For short-grip bolts, the Contractor may use direct tension indicators (DTI) with solid plates to perform the calibrated-wrench verification test instead of a tension-measuring device. Verify the DTI lot first with a longer-grip bolt in the tension measuring device. The Department will specify the test frequency. Calibrate the device annually.

iv. *Tensioning Fastener Assemblies*. Tension and inspect bolt/nut/washer assemblies to the minimum tension specified in Table 615.03-5. Use impact wrenches to tension each bolt in approximately 10 seconds.

Table 615.03-5. Minimum Required Bolt Tension (U.S. Customary Units)

Bolt Diameter (inch)	ASTM A325 (pound)	ASTM A490 (pound)
1/2	12,000	15,000
5/8	19,000	24,000
3/4	28,000	35,000
7/8	39,000	49,000
1	51,000	64,000
1-1/8	56,000	80,000
1-1/4	71,000	102,000
1-3/8	85,000	121,000
1-1/2	103,000	148,000

Do not reuse ASTM A490 fasteners and galvanized ASTM A325 fasteners. The Contractor may reuse other ASTM A325 bolts, if approved. Prohibit touching up or re-torquing previously tensioned bolts that may have been loosened by the tensioning of adjacent bolts as the torquing continues from the initial position, and that do not require greater rotation, including the tolerance, than that required by Table 615.03-6.

Table 615.03-6. Nut Rotation from the Snug Condition

	Geometry of Outer Faces of Bolted Parts		
Bolt length measured from underside of head to end of bolt	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.
≤ 4 diameters	1/3 turn	1/2 turn	2/3 turn
> 4 diameters, but ≤ 8 diameters	1/2 turn	2/3 turn	5/6 turn
> 8 diameters, but ≤ 12 diameters	2/3 turn	5/6 turn	1 turn

Install bolts in all holes of the connection and bring the connection to a snug condition.

Snug systematically from the most rigid part of the connection to the free edges. Repeat until the full connection is in a snug condition.

The minimum required bolt tension is 70 percent of the specified minimum tensile strength of bolts (ASTM Specifications for tests of full-size A325 and A490 bolts, loaded in axial tension) rounded to the nearest 1,000 pounds.

For situations in which the bolt length measured from the underside of the head to the end of the bolt exceeds 12 diameters, determine the required rotation by tests in a suitable tension device simulating the actual conditions.

v. *Rotational Capacity Tests*. Test for rotational capacity after galvanizing. Perform tests for all fastener assemblies. Include washers as part of the test even if they are not required as part of the installation procedure.

Perform the rotational capacity test according to ASTM A325 and as follows: Test each combination of bolt production lot, nut lot, and washer lot as an assembly. The Contractor does not have to include washers not required by the installation procedures in the lot identification. Assign a rotational capacity lot number to each combination of lots tested. Test a minimum of two assemblies per rotational capacity lot.

For bolts that are long enough to fit in a Skidmore-Wilhelm Calibrator, assemble the bolt, nut, and washer assembly in this device or an acceptable equivalent.

Ensure the torque necessary to produce the required fastener tension does not exceed the value obtained by the following equation:

$$\text{Torque} \leq 0.25PD$$

where:

Torque = measured torque (foot-pounds)

P = measured bolt tension (pounds)

D = bolt diameter (foot)

Test bolts that are too short to test in a Skidmore-Wilhelm Calibrator in a steel joint. Do not apply the tension requirement specified above. Instead, compute the maximum torque requirement, 0.25PD, using a value of P equal to the turn test tension taken as 1.15 times the bolt tension specified in Table 615.03-5.

vi. *Washer Requirements*. Where the outer face of the bolted parts has a slope greater than 1:20 with respect to a plane normal to the bolt axis, use a hardened beveled washer to compensate for the lack of parallelism.

Ensure that hardened beveled washers for American Standard Beams and Channels that are square or rectangular meet ASTM F436, and taper in thickness.

Hardened washers are not required for connections using ASTM A325 bolts except as follows:

A) Use hardened washers under the element turned in tightening when the tightening is to be performed by calibrated wrench method.

B) Hardened steel washers are required as part of rotational-capacity tests, even if they are not required in the actual installation.

C) Where ASTM A490 bolts are to be installed in Material having a specified minimum yield strength less than 50 kips per square inch, irrespective of the tightening method.

D) Where ASTM A490 bolts over 1.0 inch in diameter are to be installed in an oversize or short slotted hole in an outer-ply, in which case a washer of minimum thickness 0.3125 inch shall be used under both the head and the nut. Multiple hardened washers stacked upon one another shall not be used.

E) Where ASTM A325 bolts are to be installed in a long slotted hole in an outer ply, provide a plate washer or continuous bar of at least 5/16 inch thickness with standard holes. Furnish washers or bars of sufficient size to completely cover the slot after installation. Use a single hardened washer conforming to ASTM F436, but with a minimum thickness of 5/16 inch, or use a washer or bar of structural grade Material. Do not use multiple hardened washers to achieve a thickness of 5/16 inch.

vii. *Turn of Nut Installation Method*. For the turn of the nut installation method, hardened washers are not required in this installation method, except as specified in Section 615.03.D.6.c.v.

Check a representative sample of not fewer than 3 bolt and nut assemblies of each diameter, length, and grade to be used in the Work. Use a device capable of indicating bolt tension. Demonstrate that the method used by the bolting crew to develop a snug condition and to control the turns develops a tension of not less than 5 percent greater than the tension required by Table 615.03-5. Retest as required.

Following the snug-tightening operation, tension bolts in the connection by the amount of rotation specified in Table 615.03-6. During the tensioning operation, ensure that there is no rotation of the part not turned by the wrench. Tension systematically from the most rigid part of the joint to the free edges.

viii. *Calibrated Wrench Installation Method*. Use the calibrated wrench installation method only when wrenches are calibrated on a daily basis and when a hardened washer is used under the turned element. Standard torques determined from tables or from formulas that are assumed to relate torque to tension are acceptable.

When using calibrated wrenches for installation, set them to deliver a torque calibrated to produce a tension of not less than 5 percent in excess of the minimum tension specified in Table 615.03-5. Calibrate the installation procedures by verification testing at least once each Working Day for each fastener assembly lot that is being installed that day. Verify by testing three typical fastener assemblies from each lot in a tension-measuring device capable of

indicating actual bolt tension. Sample bolts, nuts, and washers under the turned element from production lots. Recalibrate wrenches when there is a significant difference in the surface condition of the bolts, threads, nuts, or washers. Verify during installation in the assembled steel work that the wrench adjustment selected by the calibration does not produce a nut or bolt head rotation from snug condition greater than that allowed in Table 615.03-6. For manual torque wrenches, measure as nuts are torqued in the tensioning direction.

When using calibrated wrenches to install and tension bolts in a connection, install bolts with hardened washers under the turned element. Snug and then tension the connection using the calibrated wrench. Tension systematically from the most rigid part of the joint to its free edges. Return the wrench to "touch up" previously torqued bolts that may have relaxed as a result of the subsequent tensioning of adjacent bolts. Continue until all bolts are tensioned as required.

ix. *Direct Tension Indicator Installation (DTI) Method*. When tightening of bolts using DTI devices is used, assemble a representative sample of not less than three devices, for each diameter and grade of fastener to be used in the Work, in a calibration device capable of indicating bolt tension. Include flat-hardened washers in the test assembly, if required in the actual connection, arranged as those in the actual connections to be tensioned. Use the calibration test to demonstrate that the device indicates a tension not less than 5 percent greater than that specified in Table 615.03-5.

When bolts are installed using DTIs conforming to the requirements of ASTM F959, install bolts in all holes of the connection and bring them to snug tight conditions. Snug tight is indicated by partial compression of the direct tension indicator protrusions. Provide a maximum gap of 0.005 inch after installation. Then tighten all fasteners, progressing systematically from the most rigid part of the connection to the free edges, in a manner that will minimize relaxation of previously tightened fasteners.

x. *Lock Pin and Collar Fasteners*. Install lock pin and collar fasteners using approved methods.

xi. *Inspection*. Inspect, in the presence of the Engineer, the tightened bolts using a calibrated torque wrench, unless alternate fasteners or direct tension indicator devices are used, allowing verification by other methods. Conduct the inspection before a loss of lubrication or corrosion influences the tightening torque.

Place three fastener assembly lots in the same condition as those under inspection in a device calibrated to measure bolt tension. Conduct this calibration operation at least once each inspection Day. Use a washer under the turned element in tensioning each bolt if washers are used on the structure. If washers are not used, ensure that the Material used in the tension-measuring device abutting the part turned is of the same Specification as that used on the Structure. In the calibrated device, tension each bolt to the specified tension. Apply the inspecting wrench to the tensioned bolt to determine the torque required to turn the nut or head 5 degrees (approximately 1 inch at a 12 inch radius) in the tensioning direction. The job inspection torque is the average of the torque required for all three bolts.

Randomly select 10 percent (at least two) of the tensioned bolts in each connection. Apply the job inspection torque to each selected bolt with the inspecting wrench turned in the tensioning direction. If this torque turns no bolt head or nut, consider the bolts in this connection to be properly tensioned. If the torque turns one or more bolt heads or nuts, apply the job inspection torque to all bolts in the connection. Re-torque and re-inspect any bolt whose head or nut turns.

7. *Welding*. Ensure that welding, welder qualifications, and prequalification of weld details and inspection of welds meet *AASHTO/AWS D1.5 Bridge Welding Code*.

Do not weld or tack brackets, clips, shipping devices, or other Material not required to any member, unless specified.

E. *Erection*:

1. *Falsework and Forms*. For Falsework and forms, meet Section 604.

2. *Handling and Onsite Storing of Materials*. Store Material on skids. Keep storage area clean and properly drained. Store girders and beams upright. Support long members to prevent damage from deflection. If the Department is furnishing the Material, check Material received against the shipping lists and report shortage or damage promptly in writing. Assume responsibility for damaged or lost Material.

3. *Bearings and Anchorages*. Bearings and anchorages must meet Section 623. Verify substructure dimensions and elevations before ordering superstructure Materials for staged construction Projects.

4. *Erection Procedure*. Follow erection procedures as detailed in the submitted erection drawings. Prepare and submit revised erection drawings detailing all proposed deviations. Recalculate and submit erection stresses that differ from the planned method. Document changes in stresses or in behavior for the temporary and final Structures. Provide additional Material required to keep both the temporary and final stresses within the allowable limits used in design.

   Provide temporary bracing or stiffening devices to accommodate handling stresses in individual members or segments of the Structure during erection.

   Support segments of the Structure to produce the proper alignment and camber in the completed Structure. Install cross frames and diagonal bracing to provide stability and ensure correct geometry. Provide all required temporary bracing.

5. *Field Assembly*. Assemble using match marks. Ensure parts are not damaged or distorted. Clean bearing surfaces and surfaces to be in permanent contact before assembly. Fill a minimum one half of the holes in splices and field connections with bolts and cylindrical erection pins (half-bolts and half-pins) before installing and tightening the balance of high-strength bolts. Fill three fourths of the holes in splices and connections carrying traffic during erection.

   Fitting-up bolts may be the same high-strength bolts used in the installation. If other fitting-up bolts are required, use the same nominal diameter as the high-strength bolts. Use cylindrical erection pins that are 1/32 inch larger than the bolts.

6. *Pin Connections*. Furnish pilot and driving nuts in driving pins. Drive pins to take full bearing. Tighten pin nuts and burr the thread at the face of the nut with a pointed tool.

7. *Misfits*. Correct minor misfits by a minor amount of reaming, cutting, grinding, and chipping at the contractor's expense. Errors in shop fabrication or deformation resulting from handling and transporting is cause for rejection.

F. *Steel Structures Repair:*

1. *Replacing Steel Rivets/Bolts*: Replace rivets/bolts with high strength bolts at locations identified in the Contract Documents.

   Where a group of rivets/bolts are being replaced, remove one rivet at a time. Immediately replace the rivet/bolt with a high-strength bolt before the next rivet/bolt is removed.

2. *Welding Repair*: Ensure that welding removal and repair, welder qualifications, and prequalification of weld details and inspection of welds meet *AASHTO/AWS D1.5 Bridge Welding Code*.

3. *Heat Straightening Damaged Steel Girders*: Brace the damaged girders sufficiently to control movements occurring during stress relief. Erect work platforms from the ground. Do not attach work platforms to the superstructure.

   The desired intent of the heating process is to relieve the girders of deformation and stresses. Incorporate high heat input into the localized areas of the steel, with a minimum amount of heat spread into the surrounding Material. Utilize an approximately 1 inch diameter, #3, multi-orifice (Rosebud) heating torch operating on approximately 25 pounds per square inch MAPP and 125 pounds per square inch oxygen (smaller torches are ineffective and larger torches are ineffective and tend to cause distortion). Obtain approval of the Equipment from the Engineer prior to its use.

Confine heating to the patterns described herein or as directed by the Engineer. Conduct heating such that the desired steel location is heated to between 1000 degrees Fahrenheit and 1100 degrees Fahrenheit, as rapidly as possible, without overheating. Any heating procedures that heat any location on the girder to a temperature greater than 1200 degrees Fahrenheit shall be considered destructive heating. Repair or replace steel damaged by overheating at the Contractor's expense.

Confine heating patterns to the areas required to bring the member back to its original position. Heat pattern location areas will be approved in the field by the Engineer prior to the beginning of the process.

During heating operations, in order to measure the intensity of heat, provide and use temperature indicating crayons manufactured for 600 degrees Fahrenheit, 1000 degrees Fahrenheit, 1100 degrees Fahrenheit, 1200 degrees Fahrenheit, and 1250 Fahrenheit temperature limits.

Quenching with water, or water and air, will not be permitted. Cooling with dry compressed air will be permitted after the steel has cooled to 600 Fahrenheit.

After the deformation is removed from the beam to the satisfaction of the Engineer, clean and paint the entire surface area indicated in the Contract Documents in accordance with the applicable requirements of Section 616. Match the paint color of the steel beam under repair to the color of the existing paint.

615.04 Method of Measurement.

The Engineer will measure Work acceptably completed as specified in Section 109.01 and as follows:

A. The Engineer will compute pay quantities for each type of steel and iron from Working Drawings using Table 615.04-1:

Table 615.04-1. Mass Densities of Steel and Iron

Material	Mass Density, lb/ft^3
Cast Iron	445
Malleable Iron	470
Wrought Iron	487
Steel-rolled or cast	490

B. The Engineer will compute the weight of rolled shapes on the basis of nominal weight per foot as specified, or listed in AISC Manual of Steel Construction.

C. The Engineer will compute the weight of castings from the dimensions shown on the approved shop drawings, deducting for open holes. The Engineer may substitute scale weight for computed weight in the case of castings or of small complex parts.

D. The measurement will exclude the weight of temporary erection bolts, shop and field paint, boxes, crates, and other containers used for shipping, and Materials used to support members during transportation and erection.

The measurement will also exclude the weight of any additional Material required to accommodate erection stresses resulting from the Contractor’s choice of erection methods.

E. The measurement will make no allowances for the weight of paint or galvanizing.

F. The Engineer will measure all metal parts other than metal reinforcement for concrete, such as anchor bolts and nuts, shoes, rockers, rollers, bearing and slab plates, pins and nuts, shear studs, stiffeners, diaphragms, roadway drains and scuppers, weld metal, bolts embedded in concrete, cradles and brackets, railing, and railing posts, as structural steel, unless otherwise stipulated.

G. The Engineer will compute pay weight on the basis of computed net weight using one of the following:

1. The Engineer will compute the weight on the basis of the net finished dimensions of the parts as specified, deducting for copes, cuts, clips, and all open holes, except bolt holes.
2. The measurement will include the weight of heads, nuts, single washers, and all high tensile strength bolts, both shop and field, on the basis of the specified edition of the AISC Manual of Steel Construction.

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3. The measurement will include the weight of fillet welds as specified in Table 615.04-3:

Table 615.04-3. Weight of Fillet Welds

Fillet Weld (inch)	Weight (lb/ft)
3/16	0.08
1/4	0.14
5/16	0.22
3/8	0.30
1/2	0.55
5/8	.080
3/4	1.10
7/8	1.49
1	2.00

615.05 Basis of Payment.

The Engineer will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
615000	STEEL STRUCTURES	LB
615001	STEEL STRUCTURES	LS
615002	STEEL STRUCTURES (UNPAINTED)	LB
615003	STEEL STRUCTURES (UNPAINTED)	LS
615004	REPLACING STEEL RIVETS/BOLTS	EA
615005	STEEL STRUCTURE REPAIR	LB
615006	STEEL STRUCTURE REPAIR	LS
615007	WELDING REPAIR	LF

Such payment is full compensation for furnishing all Materials, Equipment, labor, and all incidentals required to complete the Work as specified.

SECTION 616 – STEEL COATINGS

616.01 Description.

Furnish and apply the systems of coatings including recoating for steel Structures.

616.02 Materials.

A. Furnish paint systems for coating structural steel that are Northeast Protective Coating Committee (NEPCOAT)-approved and listed on the NEPCOAT Qualified Products List (QPL). Only products on the NEPCOAT QPL that have successfully tested below the VOC limits of 340 g/l for the organic zinc rich primer coat and below 250 g/l for the intermediate and top coats may be used. Use the appropriate paint type for the application as follows:

1. Use a paint system from NEPCOAT Qualified Products List A for shop-painted new structural steel.
2. Use a paint system from NEPCOAT Qualified Products List B for existing painted structural steel.
3. Use a different color for each coat (i.e., primer, intermediate, and finish coat). The color of the primer and intermediate coat can be the Contractor's option but must provide contrast with the underlying substrate or previously applied paint. Do not mix or match different coats from different paint systems.
4. Use a finish coat color that matches chip number 24172 (green) of FED-STD-595C for all structural steel except weathered steel, unless otherwise specified in the Contract Documents.
5. Use a finish coat color that matches chip number 30059 (brown) of FED-STD-595C for weathered steel, unless otherwise specified in the Contract Documents.

B. Use recyclable metallic shot and metallic grit meeting the requirements of SSPC AB2 and SSPC AB3 as abrasive materials for removing paint.

616.03 Construction.

A. Basis of Acceptance

1. Submit the Coating Manufacturer's written certification for approval to the DelDOT Materials and Research to confirm that the coating(s) being used meets the NEPCOAT Qualified Products List for all components of the system (primer, intermediate, and finish) prior to the start of painting. The Engineer shall confirm that the product used in the field meets that of the product approved by DelDOT Materials and Research.
2. Submit, for approval, the Coating Manufacturer's Technical Data Sheets for each coat (primer, intermediate, and finish)to the DelDOT Materials and Research Engineer detailing items including, but not limited to, the following:
    a. Temperature Range for Storage
    b. Profile Range
    c. Temperature for Application
    d. Cure to Handle/Overcoat Schedule
    e. Humidity and Dew Point Restrictions
    f. Mixing Recommendations
    g. Thinners allowed and resulting VOC levels
    h. Recoat Window
    i. Paint Film Thickness Range, Wet and Dry-Film Values
    j. Surface preparation requirements

k. Application Requirements

l. Minimum and Maximum Recoat times

3. Use only paint arriving at the work site in new, unopened containers. Label all containers of paint with the manufacturer's name, product name, component part, batch number, date of manufacturer, and shelf life date. Immediately remove from the site paint in containers having expired shelf life dates.

B. Containment System

1. Prior to commencing any cleaning operations, prepare a Contaminant System for the capture, containment, collection, and storage of the waste generated by the work, which includes abrasive blasting residue, spent blasting mediums, rust, paint particles, dust, etc.

2. The Containment System must be capable of containing the waste and resulting residue generated by the work, strive to achieve total containment (100 percent), and meet all Federal, State, and Local regulations using the best available technology as applicable to each bridge site. Ensure that the Containment System meets the requirements of SSPC Guide 6, Class 1A. Visible emissions in excess of SSPC Guide 6, Level 1 (one percent in the work day) shall be cause for immediate shut down until corrections are made.

3. While on the site, hold tarps securely in place and keep sealed at all times during water-blasting, paint removal, and painting.

4. For Bridges over water, the Containment System must include a skimming boom consisting of a float with a skirt to collect floating debris. Also, place an approved capturing device, such as a floating curtain, screen, or tarp under and downwind of the bridge, to catch rust, sand, and paint particles. Clean the waste material collected on the capturing device daily.

5. Prior to commencing work, submit Working Drawings to the Department within 14 Days from Notice of Award in accordance with the following:

a. Submit Working Drawings, sealed by a Professional Engineer registered in the State of Delaware, in accordance with Section 105.04 of the Standard Specifications.

b. Show the Containment System in plan & elevation views, including details of clips and hangers.

c. Include locations and magnitudes of all loads from the proposed Containment System on the existing Structure, including dead, live, blast waste, and wind loads.

d. Indicate maximum permissible load of abrasive or waste permitted on the Containment System.

e. Indicate if vehicles with abrasive and waste will be permitted on the Bridge; if so, indicate allowable load and locations. Vehicle and Equipment loads may not be permitted behind abutments if surcharging results.

f. Indicate all restrictions on Bridge including any load-posting.

g. Permanent attachments or fasteners to the bridge will not be permitted.

h. Show the location(s) of skimming boom(s) and capturing device(s) if the Bridge is over water.

i. Identify all Containment System components and indicate all rigid framework, work platform, and scaffolding.

j. Weight down all curtains, screens, or tarps used for containment.

k. Identify points of attachment to the Structure and ensure that those locations are capable of supporting the proposed loads.

The Department will analyze and assure that the system will not induce a load on the Bridge that will create an overstress condition or otherwise affect the structural integrity of the bridge. If the Department determines that the proposed system overstresses the Bridge, submit a new system following the above process. In no case shall the Containment System, safety devices, or Equipment

encroach upon the minimum Bridge clearances indicated in the Contract Documents, unless otherwise approved by the Engineer.

6. With the submission of the Containment System Drawing(s), develop and submit for approval an Effective Safety Program to be followed during the paint removal period. The Contractor's employees, before being engaged in paint removal Work, must have proper training in accordance with the OSHA General Industry Standard.

7. The review and acceptance of the Working Drawings by the Department in no way relieves the Contractor of any responsibility for obtaining the required degree of capture, containment, and collection.

8. The Containment System must be properly maintained while Work is in progress. Do not deviate from the approved Working Drawings without prior approval of the Engineer.

9. Deny public access to all rigging, scaffolding, and the Containment Systems at all times.

C. Surface Preparation

1. Feather back the perimeter or edge of intact paint adjoining the cleaned surface and tightly adhere the adjoining paint. 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.

2. Power tool-clean surfaces only when approved by the Engineer and in accordance with SSPC-SP11.

3. Surfaces must conform to the applicable SSPC Visual Standard.

4. NEPCOAT List A – New Steel

   a. Clean surfaces specified to be coated to white metal in accordance with SSPC-SP 5.

   b. When AASHTO M 270, Grade 50W, Grade HPS 70W, Grade HPS 100W, or ASTM A 588, Grades A, B, and C weathering steels are specified for beams or girders, blast-clean only the fascia side of exterior beams or girders in the field according to SSPC-SP6. Blast-clean from the top outside (fascia) edge of the top flange to the inside edge of the bottom flange including the bottom of the bottom flange.

   c. Blast-clean the faying surfaces of splices and connections of all structural elements according to SSPC-SP10.

5. NEPCOAT List B – Existing Steel

   a. Clean surfaces specified to be coated to bare metal in accordance with SSPC-SP10.

   b. When the existing beams or girders are AASHTO M 270, Grade 50W, Grade HPS 70W, Grade HPS 100W, or ASTM A 588, Grades A, B, and C weathering steels, blast-clean only the fascia side of exterior beams or girders in the field according to SSPC-SP6. Blast-clean from the top outside (fascia) edge of the top flange to the inside edge of the bottom flange including the bottom of the bottom flange.

   c. Blast-clean the faying surfaces of splices and connections of all structural elements according to SSPC-SP10.

6. Re-blast unpainted elements that remain unassembled for a period of 12 months following the initial cleaning.

D. Painting

1. At least 5 Working Days prior to the start of Work, provide the Engineer with one copy of the approved Coating Manufacturer’s current Technical Data and Materials Safety Data Sheets for each of the approved coating Materials being furnished (primer, intermediate, finish, and/or overcoating). Follow instructions, suggestions, and precautions contained in these data sheets to the extent that they do not contradict the provisions of this Specification.

2. Prior to the start of and throughout the duration of Work, supply the Engineer with the following:
    a. One bound copy each of the most recent SSPC Surface Preparation Specifications applicable to the Contract.
    b. One bound copy of the most recent SSPC Pictorial Standard applicable to the Contract.
    c. One bound copy of the most recent SSPC Paint Application Standard applicable to the Contract.
    d. One Sling and Battery Powered Psychrometer (includes air thermometer).
    e. One set of US Weather Bureau Tables.
    f. Three Surface Thermometers, 0 - 150 degrees Fahrenheit.
    g. Electronic Dry Film Thickness Gage(s) with valid calibration documentation.
    h. One Spring Micrometer and one roll of approved adhesion test tape per span.
3. Do not paint if the atmospheric conditions outlined in SSPC-PA1 or the Coating Manufacturer's instructions are not met. The most stringent requirements govern.
4. Thoroughly mix the approved coatings in accordance with SSPC-PA1 or the Coating Manufacturer's instructions. The most stringent requirements govern.
5. Thin only with the approved Coating Manufacturer's thinner. Thinning is allowed only in strict accordance with the Coating Manufacturer's recommendations and with state VOC regulations for each approved coating. Unauthorized use of solvents will result in re-cleaning and repainting the surface in accordance with this Specification, at no cost to the Department.
6. Unless specified otherwise in the Contract Documents, before all the steel receives its first full prime coat of coating, stripe coat the following with the approved primer coating in accordance with the most current SSPC-PA1 and SSPC-PA Guide 11:
    a. Corners.
    b. Crevices.
    c. Lattice.
    d. Angles.
    e. Rivets, Bolts, and Nuts.
    f. Welds.
    g. Sharp and/or Thin Edges.
    h. In between built-up members.
    i. Top face of top flange of girders with cast-in-place concrete decks.
7. Before stripe coating, apply a 100 percent-solids rust-penetrating sealer to all crevices 1/2 inch or less, rivets, bolts, nuts, between built-up members, and/or where pack rust is present. Use only a sealer that compliments the chosen/approved NEPCOAT system recommended by the specific Coating Manufacturer and does not void the warranty. Before the finish coat, seal all crevices 1/2 inch or less, and/or where pack rust is present, with a paintable caulk.
8. Apply paint coatings using the Coating Manufacturer's requirements for each coat and the following:
    a. Apply primer the same Day as the cleaning operation and before rust back occurs. Re-clean the surface if primer is not applied within 8 hours of the surface cleaning operation.
    b. Apply intermediate coat within 14 days of the application of the primer or in accordance with the Coating Manufacturer's instructions, whichever is more stringent.

c. Apply the finish coat within 14 days of the application of the intermediate coat or in accordance with the Coating Manufacturer's instructions, whichever is more stringent.

d. Re-clean and repaint areas that are damaged due to the Contractor's Work, fail to meet the minimum required dry film thickness, that were contaminated areas when painted, or that were, according to the Engineer, painted using methods or Materials that were contrary to the Specifications in this section. Re-clean and repaint at no additional cost to the Department.

e. At the completion of the painting Work, stencil in 3 inches high letters and numbers the completion date (month and year) and the Bridge number. Use the same paint as the finish coat, except that the color must be black. Stencil this information on the outside of each fascia beam at the approaching traffic end of the Structure at a location designated by the Engineer.

Example:

BR 1-001

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E. Hazardous Material – Air Monitoring for Particulate Matter (PM-10) and Total Suspended Particulate Matter (TSP) Lead

1. The intent of the monitoring requirements in this Specification is to establish a baseline background reading for the area(s) in proximity to steel cleaning.

2. Perform all of the testing required to ensure that lead particles are adequately contained and captured by the steel cleaning operations.

3. Engage a consultant responsible for conducting air monitoring Work during the period of the paint removal operations. Submit the qualifications of the consultant for approval by the Department prior to his/her engagement in any air monitoring service. Conduct monitoring on the area downwind of the lead control area. Monitor the air quality standard in accordance with National Ambient Air Quality Standards (NAAQS). At a minimum, the containment system must achieve a SSPC Guide 6, Level 1 Standard Emissions level.

4. Record baseline monitoring at each structure where the Contractor is required to clean the existing steel in order to establish preconstruction background readings for the area(s) involved. Perform baseline monitoring for a minimum of 3 consecutive Calendar Days before the steel cleaning begins. Conduct the monitoring so that the monitored hours match the proposed Work Schedule for the Contract, including night work. The minimum duration of the monitoring for each Calendar Day must be 8 hours, regardless of the Contractor's proposed Work Schedule. The required sampling type shall be 2 (two) PM-10 and 2 (two) TSP-Lead and the Engineer must approve the locations of the sampling. During lead paint removal, commence air monitoring just prior to the start of any lead removal operation and continue whenever the steel cleaning operation is in progress. Paint removal includes blasting as well as clean-up activities. If problems with containment occur, the Engineer will require the air monitoring to be reinstalled at no cost to the Department.

5. The acceptance level for Particulate Matter (PM-10) (particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers) shall be 150 micrograms per cubic meter of air for 24-hour average concentration (450 micrograms per cubic meter of air over an eight-hour period assuming no emissions occur from the project for the remaining 16 hours).

6. The acceptance level for Total Suspended Particulate Matter (TSP) lead emissions shall be 1.5 micrograms per cubic meter of air averaged over a calendar quarter of the year, which can be converted as noted below to achieve daily lead level allowance during the project operation:

DA = (90/PD) x 1.5 micrograms per cubic meter. where

DA = Daily Allowance (micrograms per cubic meter)

PD =Number of paint removal operation days anticipated in a 90-day period.

For example, if it is expected that 30 days out of 90 will be worked, the TSP lead emission criteria for each of those days would be 4.5 micrograms per cubic meter, over a 24-hour period (90/30 x 1.5). However, since the paint removal operation will not continue for the full 24 hours, this level of emissions can be increased using the following formula:

ADA = DA x (24/H), where

ADA = Adjusted Daily Allowance (micrograms per cubic meter)

H = Hours worked in 24 hours.

Using the above example, if the paint removal operation is continued for eight hours out of each 24-hour workday, the ADA will be 13.5 micrograms per cubic meter (4.5 micrograms per cubic meter x 24/8). Thus, 13.5 $\mu g/m^3$ could be emitted during the eight hours of Work, provided no emissions occur during the remaining 16 hours.

7. Use a containment system that is an area approximately equivalent to what a work crew can blast-clean, inspect, paint, and move in a 24-hour period. The Engineer may permit a larger containment system if the Contractor can demonstrate that such a system will increase productivity and not interfere with the flow of traffic. When dust leaks are noted in the containment system, make repairs as soon as possible.

8. If the containment system fails to function at the required level of efficiency at any time during the execution of the Work, as determined by the Engineer, immediately suspend all operations except those intended to minimize the adverse impact to the environment. Operations must not resume until modifications have been made to correct the cause of the failure, to the satisfaction of the Engineer.

9. Provide for a full-time hygienist to be on the job site during lead paint removal activities to insure required hygiene procedures are being followed.

F. Collection, Storage and Disposal of Hazardous and Non-Hazardous Waste

1. All waste discharged and collected from the Containment System must be protected in a manner so as to prevent migration of the waste into the environment. Abide by all Federal and State regulations relating to collection, storage, and disposal of the hazardous waste and solid waste.

2. Provide a cleanup area with soap, water, and container for collecting and disposing of the hazardous waste at each work site. Obtain a permit for hauling the hazardous waste from the State Department of Natural Resources and Environmental Control (DNREC).

3. Each Day, collect and contain waste material in sealed 55-gallon open-head-type drums (I.C.C. Specification 17-H). All drums must be in new condition and approved for use by the Engineer. Label drums with the words "HAZARDOUS WASTE" and tag in accordance with all State regulations including Bridge number, Contract number, Contractor's name, contents, and the date when waste accumulation in the drum begins. Keep no more than 29 drums of hazardous material at the site of each Bridge.

4. The waste to be placed in drums also includes all filters used in abrasive blasting Equipment and vacuum power tools for removing hazardous and non-hazardous paint waste. At the end of the Contract, remove all such filters from Equipment used on the Project and place in drums with other hazardous waste for proper disposal.

5. At the end of each Working Day, haul the waste material contained and collected to a temporary secure accumulation site that has been pre-approved by the Engineer. Maintain the accumulation site in a secured condition. Hauling of hazardous waste must be performed by a properly licensed hauler.

6. The storage site and the accumulation site must be capable of preventing the migration of the lead-contaminated waste material into the environment. Provide both areas with protection from vandalism and unauthorized access by the general public. At the completion of the Work and in the presence of the Engineer, take representative samples of the accumulated residues collected at each Bridge.

7. Consider samples exceeding 5 parts per million according to the EPA SW-846, Test Method 1311, Toxicity Characteristics Leaching Procedure (TCLP) test as hazardous waste and dispose of accordingly. If the sample's toxicity level has dropped to 5 parts per million or less, then transport and dispose of the waste as industrial waste, provided it is stabilized.

8. In order to stabilize the industrial waste (below the toxicity level), add a slurry made from Portland Cement (10 percent of waste by volume) and water (50 percent of cement by volume) to the waste. Utilize a licensed hazardous waste hauler to thoroughly mix the slurry and waste at the disposal site. Do not dispose of blasting debris or dust collector waste as an industrial waste. Either stabilize or dispose of them as a hazardous waste, regardless of the results of the TCLP test.

9. Deliver the samples to a laboratory approved by the Department for testing according to the EPA SW-846, Test Method 1311, Toxicity Characteristic Leaching Procedure (TCLP). Should test results indicate that the contaminants listed in the following table are above their respective regulatory limits, the residue shall be deemed a hazardous waste and must be treated before disposal.

EPA HAZARDOUS WASTE NO.	CONTAMINANT	CAS NO.	REGULATORY LEVEL (mg/L)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D006	Cadmium	7440-43-9	1.0
D007	Chromium	7440-47-3	5.0
D008	Lead	7439-92-1	5.0
D009	Mercury	7439-97-6	0.2
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0

10. Remove from the accumulation site all treated waste within 90 days from the date of accumulation. Transport the treated waste to an industrial dump facility approved by the Delaware Department of Natural Resources and Environmental Control for disposal of such waste. Forward a copy of the completed waste manifest (signed and dated by the Contractor and the Engineer at the site) to the Department.

G. Coating System Warranty and Guarantee

1. Provide a warranty guaranteeing the performance of the complete coating systems, including surface preparation, Materials, and application, against failure for a period of two (2) years from the date of Final Acceptance. Have the Project Warranty and Guarantee signed and attested to by two (2) corporate officers of the Prime Contractor. The Prime Contractor, regardless of which Contractor applies the paint system, will ultimately be responsible for the Project Warranty and Guarantee.

2. Prior to the start of painting, submit to the Engineer the name, address, and phone number of the designated contact person for all issues involving the Project Warranty and Guarantee. Joint warranties or guarantees between Contractor/Sub-Contractor or Contractor/Coatings Manufacturer will not be accepted.

3. Warranty Bond

   a. Submit to the Department a warranty bond at the Final Acceptance of the Project to insure the State of Delaware of performance during the two (2)-year Project Warranty and Guarantee period.

b. The warranty bond must be in an amount equal to one hundred percent (100 percent) of the total Contract quantity paid at the Unit Prices specified in the Bid Proposal for all Items related to preparation, cleaning, Bridge painting, and maintenance of traffic, to perform 2-year required warranty work.

c. The amount of the warranty bond does not relieve the Contractor of his/her responsibility to repair all required areas within the warranty period.

d. The bond will be retained for two (2) years from the Final Acceptance date. It will be returned after the determination of ultimate acceptance, made at a joint meeting between the Engineer and the Contractor.

4. Warranty Evaluation Review

a. The Department will notify the Contractor in writing of any failure of the coating system discovered within the warranty period. This notice will sent by registered mail, or other special delivery service, cost prepaid, return-receipt-requested, to the Contractor. All such notices, when deposited in the mail or shipped, will be considered served when deposited or shipped.

b. Respond within 30 Days of said notice to acknowledge receipt and to submit a plan of action to complete the repairs.

c. The Contractor will be given full and complete opportunity, not interfering with the Department activities, to inspect and test the alleged failure and coatings.

d. During the month before the end of the warranty period, the Engineer will inspect the Bridge thoroughly for failures of the coating system. This semifinal warranty inspection will be performed jointly by the Department and the Contractor with Equipment supplied by the Contractor, without cost to the Department. The inspection Equipment shall be OSHA-approved, vehicle-mounted, and provide access to all areas of the Structure. Provide traffic control and required signing during the semifinal warranty inspection. The traffic control plan must be in accordance with the DelDOT MUTCD and must be submitted to the Department for prior approval.

5. Failure of the Coating System Definitions

a. Active Corrosion of the substrate equivalent to ASTM D610 or SSPC-VIS 2, rust grade 7 (0.3 percent of the surface) or worse; loss of adhesion from the substrate.

b. Cracking, checking, mudcracking, alligatoring, finning, wrinkling, sagging, flaking, intercoat delaminations, running, or peeling determined visually by the Engineer and verified by destruction of coating in disputed areas.

c. Sub-film corrosion determined visually by the Engineer and verified by destruction of coating in disputed areas.

d. Loss of adhesion greater than or equal to a rating of 2A in ASTM D3359 (Standard Test Methods for Measuring Adhesion by Tape Test), Test Method A: X-Cut Tape Test.

e. Erosion of the film at a rate of two (2) percent of the coating surface of any contiguous area as defined below per year or greater determined by Engineer measuring actual areas of failures.

f. Non-uniformity of topcoat color such as patches, streaks, chalking, or patterns discernible from a distance of ten feet (three meters) or greater, that cannot be eliminated by washing.

g. Failure of the coating system shall be considered to have occurred if the sum of the failures described above is greater than two (2) percent of the coating surface of any single contiguous area as defined below. The “Guide to SSPC-VIS 2” shall be used as a guide in determining failure.

h. A contiguous area is defined as:

i. Each face (including top flange and top of bottom flange) of each stringer beam in each span; or

ii. Each bottom of the lower flange in each span; or

iii. Each diaphragm; or

iv. Each bearing.

6. Warranty Repair Requirements

a. Within 120 Days after receipt of written notice, correct any failures in Materials and workmanship that develop within the guarantee period. Variations to the 120 Day requirement may be granted if the Contractor is impeded by permits, traffic control, weather, construction, or any other State projects not under the Contractor's control. Extensions will be granted as per the Engineer's recommendations.

b. Correct and/or repair any damage to other Work or property of the State of Delaware caused by defective Materials, Equipment, or workmanship when performing said warranty repairs. The Engineer will determine the degree of the repair or corrective procedure.

c. In the event the Engineer determines that there is a coating failure, the Contractor will be obligated under this Warranty and Guarantee to provide labor, Materials, and Equipment at no cost to the Department to repair and/or replace the coating system to the performance requirements of the original Contract. The extent of repair and/or replacement will be determined in a cooperative effort by the Contractor and the Engineer.

d. Maintenance of traffic and access to the failure areas, including railroad permits and coordination, will be at no cost to the Department. Recoated areas are to overlap a properly performing adjacent coating system. Any fascia girders/beams or areas visible to the public will receive a cosmetic topcoat to promote a uniform color and appearance of the painted structure. This will only occur if a failure or repair creates a discontinuity of the visible appearance, as determined by the Engineer.

7. Exclusions to the Warranty and Guarantee

a. Excluded from the Warranty and Guarantee are any and all damages that occur after acceptance of the coating system by the Engineer that are not a direct result of normal usage (i.e., collisions, fires, structural failure, acts of God, etc.). Exclusions also include any areas agreed to in writing by both the Contractor's representative and the Engineer before the initiation of the Project.

a. The foregoing guarantee and obligations shall not deprive the State of Delaware of any action, right, or remedy otherwise available for breach of any of the provisions of the Contract Documents. The periods referred to above will not be construed as a limitation on the time in which the Department may pursue such other action, right, or remedy.

616.04 Method of Measurement.

A. The quantity of shop painting of new steel will not be measured.

B. The quantity of field painting of existing steel will not be measured

C. The quantity of removal and disposal of hazardous material will not be measured.

D. The quantity of coating warranty will not be measured.

616.05 Basis of Payment.

A. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
616000	CLEANING AND PAINTING EXISTING STEEL	LS
616003	TESTING AND DISPOSAL OF EXISTING HAZARDOUS STEEL COATING	LS

B. Price and payment for shop painting of new steel is incidental to the applicable steel Structures Item and will constitute full compensation for furnishing all Materials; for providing protection against damage

during paint application; for re-establishing Project standards, if necessary; for re-cleaning when primer is not applied within eight hours of initial cleaning; for re-cleaning 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.

C. Price and payment for cleaning and painting of existing steel will be made at the Contract Lump Sum price and will constitute full compensation for removing existing coating; for disposing of non-hazardous debris; for providing the containment system; for preparing the surface; for furnishing all Materials; for providing protection against damage during paint application; for re-establishing Project standards, if necessary; for re-cleaning when primer is not applied within eight hours of initial cleaning; for re-cleaning 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.

D. Price and payment for removal and disposal of hazardous material will be made at the Contract Lump Sum price and will constitute full compensation for furnishing and installing all Materials, Working Drawings and Professional Engineer's service, Containment System, collection and temporary storage of the waste material as required, air monitoring service including consulting services, testing materials for contaminants, cleaning the Structure, revisions and resubmissions of the Containment Plan and/or Systems that may be required during the execution of the Work, for providing respiratory protection and protective clothing to the worker and Department's employee(s) at the time of inspection, hygiene facilities, for stabilizing the hazardous material and transporting and disposing of the stabilized waste complying with all the requirements as described herein, and for all labor, Equipment, tools and necessary incidentals to complete the Work.

E. All costs for providing the coating warranty will be considered as incidental to the coating (painting) Item(s) in the Contract.

SECTION 617 – STEEL SIGN STRUCTURES

617.01 Description

Furnish, fabricate, and erect steel sign Structures of the type indicated.

617.02 Materials

A. *Cantilever, Centermount, Monopipe, or Overhead with Single Plane Truss*.

1. *Columns, Struts, and Truss Chords.* Section 1039.08(E).

2. *Truss Webs and Truss Verticals.* ASTM A53, Grade B, Type E or S for tubular members; or Section 1039.08 for pipe and tubing.

3. *Steel Angles, Shapes, Plates and Backing Rings*. Section 1039.01.

B. *Overhead with Tri-Chord or Box-Shaped Truss.* As specified in Sections 617.02.A.1 and 617.02.A.2.

D. *Fabricated Structural Steel*. Section 1039.01.

E. *Anchor Bolts, Nuts, and Washers.* Section 1039.04.

F. *U-Bolts, Nuts and Washers.* Section 1039.02.

1. U-Bolt assembly galvanized according to Section 1039.10.

G. *High-Strength Fasteners.* Section 1039.03.

H. *Galvanized Steel Screen.* 1/2 inch by 1/2 inch mesh and 0.063 inch diameter galvanized steel wires.

617.03 Construction

A. *General.*

1. *Alternate Designs*. Obtain approval from the Engineer for alternate designs. Alternate designs shall be structurally equivalent. The Engineer can reject alternate designs for any reason, including aesthetics.

2. *Documentation.* Submit documentation in accordance with Section 615.03.A.

3. *Working Drawings.* Submit Working Drawings in accordance with Section 615.03.B. In addition, identify on the fabrication drawings weld locations, type, size, process, and method and procedure for non-destructive testing. Field-verify all dimensions, prior to submitting Working Drawings.

B. *Fabrication.* Fabricate in accordance with Section 615.03.C. except as noted below:

1. *Welds.* Comply with AWS D1.1 Structural Welding Code as well as the additional requirements of AASHTO *Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, Section 5.14, Welded Connections.

2. *Weld Testing*. If necessary, repair base connection welds one time. If more than one repair is necessary, obtain approval. Perform and evaluate all non-destructive testing according to cyclically loaded non-tubular tension criteria.

a. Perform the following minimum ultrasonic testing of Complete Joint Penetration (CJP) groove welds.

i. 25 percent of the length of CJP groove welds connecting each flange splice plate to the truss chords, each base plate to the tower columns, each connection plate to the chords or columns, each CJP weld on truss seat plates, and each CJP longitudinal seam weld on cantilever and center-mount sleeves. 100 percent of the length of CJP groove welds on monopipe Structures.

A) If a rejectable defect is found, then test 100 percent of the weld on that element.

ii. 100 percent of the groove weld length on at least 25 percent of the number of similar-type connections of web members to the truss chords.

A) If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

b. Perform the following minimum magnetic particle inspection (MT) of fillet welds and Partial Joint Penetration (PJP) groove welds.

i. Intermediate member connections: MT 100 percent of the weldment length on at least 25 percent of the total number of connections on trusses and towers, respectively.

A) If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

ii. Welds on truss seat plates, base plates, cantilever and center-mount sleeves, and alternate press-break members and fillet welds connecting backing rings to base plates and flange splice plates: MT a minimum of 25 percent of the total length of each weld.

A) If a rejectable defect is found, then test 100 percent of the weld on that element.

iii. Welds attaching handhole frames to columns: MT 100 percent of the length of each weld.

iv. All other connections: MT 100 percent of the weldments on at least 10% of the total number of connections.

A) If any rejectable defect is found, double the testing frequency until no rejectable defects are discovered.

c. The Department's plant Inspector will select weld locations and weldments to be tested.

d. Perform Ultrasonic Inspection of the groove weld prior to welding top of the backing ring. Perform 100 percent ultrasonic inspection (UT) of butt welds in rings 5/16 inch and thicker. Perform 100 percent MT on rings less than 5/16 inch thick.

3. *Backing Ring.* Fabricate backing ring as a continuous ring or butt-welded with a full-penetration weld.

4. *Bending.* Form columns for monopipe sign Structures to the radii shown in the Contract Documents in accordance with the Tube and Pipe Association International Recommended Standards for Induction Bending of Pipe and Tube (TPA-IBS-98).

5. *Galvanizing.*

a. Galvanize all steel members and fasteners in accordance with Section 1039.10.

b. Fabricate steel sign Structure into the largest practical unit prior to galvanizing. Submit splice locations to the Engineer for approval. Do not fabricate steel sign Structure until such splice locations are approved.

C. *Foundation.* Excavate and construct the foundations as shown in the Contract Documents. Slope top of pedestal 4 percent from center to near edges for drainage.

1. *Drilled Shafts.* In accordance with Section 606.

2. *Spread Footings.* In accordance with Section 207, Section 209, Section 610, and Section 611.

3. *Anchor Bolts.*

a. Use steel templates provided by the fabricator to accurately set tower base anchor bolts to the correct elevation and alignment. Securely brace the bolts against displacement before concrete is placed.

b. Pretension anchor bolts according to the following procedure:

i. Verify that the nuts can be turned onto the bolts past the elevation corresponding to the bottom of each in-place leveling nut and be backed off by the effort of one person using a 12-inch-long wrench or equivalent (i.e., without employing a pipe extension on the wrench handle).

ii. Clean and lubricate the exposed threads of all anchor bolts. Clean and lubricate the threads and bearing surfaces of all leveling nuts. Re-lubricate the exposed threads of the anchor bolts and the threads of the leveling nuts if more than 24 hours has elapsed since earlier lubrication, or if the anchor bolts and leveling nuts have become wet since they were first lubricated.

iii. Turn the leveling nuts onto the anchor bolts and align the nuts to the same elevation.

iv. Place structural washers on top of the leveling nuts (one washer corresponding to each anchor bolt).

v. Install the base plate atop the leveling nuts, place structural washers on top of the base plate (one washer corresponding to each anchor bolt), and turn the top nuts onto the anchor bolts.

vi. Tighten top nuts to a snug-tight condition in a star pattern. Snug-tight is defined as the maximum nut rotation resulting from the full effort of one person using a 12-inch-long wrench or equivalent. A star tightening pattern is one in which the nuts on opposite or near-opposite sides of the bolt circle are successively tightened in a pattern resembling a star. (For example, for an 8-bolt circle with bolts sequentially numbered 1 to 8, tighten nuts in the following bolt order: 1, 5, 7, 3, 8, 4, 6, 2.)

vii. Tighten leveling nuts to a snug-tight condition in a star pattern.

viii. Before final tightening of the top nuts, mark the reference position of each top nut in a snug-tight condition with a suitable marking on one flat with a correspondence reference mark on the base plate at each bolt. Then incrementally turn the top nuts using a star pattern until achieving the required nut rotation specified in Section 615, Table 615.03-6. Turn the nuts in at least two, full tightening cycles (passes). After tightening, verify the nut rotation.

ix. Tighten top bolt of double-nut assembly to snug-tight.

c. Verify base plate is in full contact with all flat washers.

d. Burr off threads of anchor bolts at face of nut after column is installed.

4. *Grout Pad.* Do not use grout between the base plate and concrete pedestal.

5. *Galvanized Steel Screen.* Seal the gap between the base plate and the foundation with a galvanized steel screen. Install galvanized steel screen to prevent entry of rodents while permitting drainage. Cover the entire gap with a wire screen, the bottom horizontal wire of which shall be in full contact with the surface of the concrete foundation and the top horizontal wire of which shall not extend beyond the top surface of the base plate. Vertical screen wires shall not extend beyond the top and bottom horizontal wires of the screen. Use one continuous section of screen with only one overlapping splice where the ends come together and overlap the layers 3 inches minimum. Attach the screen to the vertical side of the base plate with self-tapping stainless steel screws (No. 8, 1/2 inch long) with stainless steel washers (1/4 inch inside diameter). Drill pilot holes into the base plate to facilitate screw installation. Install screws on 9 inch centers maximum and at least one screw shall be installed through the overlapping splice to clamp the layers together. Also clamp the overlapping splice layers together just above the concrete foundation with an all-stainless-steel fastener assembly consisting of a machine screw (No. 8, 5/8 inch long), nut and two flat washers (1/4 inch inside diameter) and lock washer. Tightly clamp the screen layers between the flat washers.

617.04 Method of Measurement

A. The quantity of Steel Sign Structures placed and accepted will not be measured.

617.05 Basis of Payment

A. The Engineer will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
617000	STEEL SIGN STRUCTURE, TUBULAR ARCH, CANTILEVER	LS
617001	STEEL SIGN STRUCTURE, TUBULAR ARCH, OVERHEAD	LS
617002	STEEL SIGN STRUCTURE, TRUSS TYPE, CANTILEVER	LS
617003	STEEL SIGN STRUCTURE, TRUSS TYPE, OVERHEAD	LS
617004	STEEL SIGN STRUCTURE, BRIDGE MOUNTED	LS

B. Price and payment for Steel Sign Structures constitutes full compensation for furnishing, fabricating, and installing all Materials and all incidentals required to complete the Work.

C. Payment for the foundation will be made under separate Contract Items. Payment for the sign panels will be made under separate Contract Items.

D. Submit the breakout sheet included in the Proposal that lists all of the Steel Sign Structures under this Item. Fill in a Unit Price for each Steel Sign Structure. The lump sum bid for the respective pay Item will be the sum of the price for all Sign Structures listed on the breakout sheet. Attach the breakout sheet to the Bid Proposal. Failure to submit the breakout sheet with the Bid Proposal will result in the Bid Proposal being declared non-responsive and being rejected.

SECTION 619 – STONE AND BRICK MASONRY

619.01 Description.

Furnish and construct, reconstruct, or repair stone or brick masonry.

619.02 Materials.

A. Provide Portland cement in accordance with Section 1022.

B. Provide fine aggregate in accordance with Section 1003.

C. Provide water in accordance with Section 1021.

D. Provide stone of the type and dimensions as detailed and specified in the Contract Documents and in accordance with Section 1040. Stone must be free of iron content significant enough to cause rust-staining of the stone or Materials below the stone. Submit samples of stone for approval prior to starting Work.

1. For repair or reconstruction, use salvaged stone from the site or provide stone to match existing stone types, colors, sizes, shapes, and patterns as close as possible, to the satisfaction of the Engineer.

E. Provide brick in accordance with Section 1040. Submit samples of brick for approval prior to starting Work.

1. For repair or reconstruction, provide brick to match existing stone types, colors, sizes, shapes, and patterns as close as possible, to the satisfaction of the Engineer.

F. Provide steel wall ties or dovetails that are hot-dipped galvanized in accordance with Section 1039.10 or stainless steel in accordance with AASHTO M 163.

619.03 Construction.

A. *Excavation*. Excavate to the required depth when necessary in accordance with Section 207.

B. *Mortar*. Mix mortar in the proportion of one part Portland Cement to three parts fine aggregate, then add hydrated lime not to exceed 10 percent of the cement by weight. Mix the fine aggregate, Portland Cement, and lime in an approved manner until the mixture assumes a uniform color. Add water as needed while the mixing continues until the mortar attains such consistency as can be easily handled and spread with a trowel. Place mortar to form a firm bond. Dispose of mortar that is not used within 30 minutes after water has been added. Re-tempering of mortar will not be permitted.

C. *Placing Masonry.*

1. Do not perform any masonry work when the temperature is below 40 degrees Fahrenheit.

2. *Stone*. Use only experienced stone masons to perform the Work. Lay the stone to the wall to form the pattern shown in the Contract Documents. Thoroughly wet the stone before laying in mortar. Fill all joints completely with mortar and finish properly as work progresses. Mortar joints must be 1 inch to 1-1/2 inches thick.

3. *Brick*. Use only competent and experienced bricklayers to perform the Work. Lay bricks by means of the shove-joint method so as to thoroughly bed them into the mortar. Buttered or plastered joints will not be permitted. Arrange all brick headers and stretchers so as to thoroughly bond the mass with alternate courses breaking joints. Fill all joints completely with mortar and finish properly as the Work progresses. Joints must be 1/4 inch to 1/2 inch thick. Spalls or bats are not permitted for use except for shaping irregular openings or when unavoidable to finish out a course. If spalls or bats are necessary and approved by the Engineer, place full bricks at the corners and place bats in the interior of the course.

D. *Cleaning.* After constructing the masonry, thoroughly clean the entire area of all efflorescence, mortar, scars, or spots to present a natural color. Clean the entire area with water, then treat with a solution of 1 percent hydrochloric acid, and then finally wash thoroughly again with water. When cleaning stone

masonry with the solution, Contractor must be watchful to notice any deteriorating reaction. If a reaction is noticed, Contractor must stop using the solution and wash the treated area immediately. However, the Contractor is responsible to ensure the stone masonry is cleaned to present the natural color.

E. *Pointing Existing Masonry*. Rake all deteriorated and loose mortar from the joints. Clean the joints with water under high pressure. Remove excess water from the cavity with air under high pressure. Ensure all joints are thoroughly wetted before applying the mortar. Mix and place mortar in accordance with Section 619.03.B. Use only mortar that matches in color to the existing mortar. In hot or dry weather, protect the pointing Work from the sun and keep wet for a period of 3 days after completion.

F. *Reconstructing Existing Masonry*. Exercise care when handling to avoid breaking and scarring existing masonry. Do not drop existing masonry. Reuse exposed surfaces of existing stone in the reconstructed Structure except as directed by the Engineer. Ensure that the reconstruction results in a Structure that resembles the original and adjacent Structures in overall appearance. Where applicable, additional historical and restoration notes will be included in the Contract Documents and will require coordination with the Department's Environmental Studies Section.

G. *Backfilling*. Backfill the excavated areas in accordance with Section 207.

619.04 Method of Measurement.

A. The Engineer will measure the quantity of stone masonry by the square foot placed and accepted.

B. The Engineer will measure the quantity of brick masonry by the square foot placed and accepted.

C. The Engineer will measure the quantity of pointing masonry by the linear foot of joints pointed and accepted.

D. The Engineer will measure the quantity of reconstructing existing stone masonry by the square foot or cubic foot of existing stone masonry reconstructed and accepted.

E. The Engineer will measure the quantity of reconstructing existing brick masonry by the square foot or cubic foot of existing brick masonry reconstructed and accepted.

619.05 Basis of Payment.

A. The Engineer will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
619000	STONE MASONRY	SF
619001	BRICK MASONRY	SF
619002	POINTING EXISTING MASONRY	LF
619020	RECONSTRUCTING STONE MASONRY	SF
619021	RECONSTRUCTING STONE MASONRY	CF
619030	RECONSTRUCTING BRICK MASONRY	SF
619031	RECONSTRUCTING BRICK MASONRY	CF

B. The quantity of stone masonry will be paid for at the Contract Unit Price per square foot. Price and payment will constitute full compensation for furnishing, placing, and cleaning stone masonry and all incidentals needed to complete the Work. Payment for excavation and backfilling will be made under the respective pay Items.

C. The quantity of brick masonry will be paid for at the Contract Unit Price per square foot. Price and payment will constitute full compensation for furnishing, placing, and cleaning stone masonry and all incidentals needed to complete the Work. Payment for excavation and backfilling will be made under the respective pay Items.

D. The quantity of pointing masonry will be paid for at the Contract Unit Price per linear foot. Price and payment will constitute full compensation for furnishing all Materials, for pointing the joints as described above, and for all incidentals required to complete the Work.

E. The quantity of reconstructing stone masonry will be paid for at the Contract Unit Price per square foot or cubic foot. Price and payment will constitute full compensation for removing and stockpiling existing stone, disposing of unsuitable materials, furnishing, placing, and cleaning stone masonry and all incidentals needed to complete the Work. Payment for excavation and backfilling will be made under the respective pay Items.

F. The quantity of reconstructing brick masonry will be paid for at the Contract Unit Price per square foot or cubic foot. Price and payment will constitute full compensation for removing and stockpiling existing brick, disposing of unsuitable materials, furnishing, placing, and cleaning brick masonry and all incidentals needed to complete the Work. Payment for excavation and backfilling will be made under the respective pay Items.

SECTION 621 – WOOD STRUCTURES

621.01 Description.

Construct wood Structures and the wood portions of composite Structures including furnishing, preparing, fabricating, erecting, treating, and painting of wood and hardware.

621.02 Materials.

Provide Materials as specified in:

Wood	Section 1041

621.03 Construction.

A. Ensure that all framing is true and exact. Drive nails and spikes with force just sufficient to set the heads flush with the surface of the wood. The Engineer may consider hammer marks in wood surfaces as evidence of poor quality and as sufficient cause to call for removal of the worker who caused them.

B. Stack all lumber and timber on the site of the Work to prevent warping. Stack untreated Material on supports at least 12 inches above the ground surface and open-stacked. Stack treated material on supports at least 12 inches above the ground surface and close-stacked. Provide acceptable cover to protect all Material from the weather.

C. *Treated Wood:*

1. *Handling*. Avoid damage to treated timber and handle the timber only with web slings. Provide corner protectors when metal bands are used to bundle members.

2. *Framing and Boring*. Cut, frame, and bore treated timbers before treatment insofar as is practicable. Place untreated cuts, borings, or other joint framings above the high-water elevation when treated timbers are to be placed in waters inhabited by marine borers.

3. *Cuts and Abrasions*. Field-treat all cuts, abrasions, and recesses that occur after treating timbers in accordance with Section 1041.04(E).

4. *Bored Holes*. Treat holes bored after treatment in accordance with Section 1041.04(E). After treatment, plug holes that are not filled with bolts or other items with preservative-treated plugs.

5. *Temporary Attachments*. Treat holes resulting from forms or temporary braces that are attached to treated timber with nails or spikes, as required for bored holes, and fill by driving galvanized nails, spikes, or preservative-treated plugs flush with the surface.

D. *Connectors and Fasteners:*

1. *Installing Connectors*. When installing split rings and shear plates, use precut grooves of the specified dimensions or as recommended by the manufacturer. Force spike grids into the wood so that members will be in firm contact. Use pressure Equipment that does not damage the wood surface. Replace temporary high-strength bolts with specified bolts for the final installation. Embed all connectors at the joint simultaneously and uniformly. Cut connector grooves in wood, concentric with the bolt hole. Make grooves conform to the cross-sectional shape of the rings, and provide a snug fit. Make the inside groove diameter larger than the nominal ring diameter. Fabricate structural members using connectors prior to preservative treatment. Drill bolt holes perpendicular to the face of the member. Store wood, after fabrication, in a manner that prevents changes in the dimensions of the members before assembly. Cure the wood before fabrication so that its dimensions remain stable. Reject wood that shrinks during storage, causing predrilled grooves for split rings, plate size, or bolt hole spacing to change.

2. *Fastenings*. Drill the holes for round drift bolts and dowels 1/16 inch less in diameter than the bolt or dowel. Drill holes for square drift bolts or dowels equal in diameter to the least dimension of the bolt or dowel. Drill the holes for machine bolts 1/16 inch greater than the diameter of the bolt.

Drill the holes for lag screws with a bit not larger than the body of the screw at the base of the threaded portion. Drill the hole for the shank 1/16 inch greater than the diameter of the shank and to the same depth as the shank. Use a washer under bolt heads and nuts that would otherwise come in contact with wood (except for timber bolts with economy-type heads). Tighten all nuts to a snug fit condition. Retighten all nuts after full assembly. Lock the nuts of bolts after final tightening by burring or other approved method.

3. *Countersinking*. Countersink hardware when smooth or flush surfaces are required. Treat all recesses formed for countersinking in treated timber, as specified in Section 1041.04(E).

E. *Framing*. Cut and frame lumber and timber to a close fit so that the joints will have even bearing over the entire contact surfaces without requiring shims. Open joints will be rejected.

F. *Caps*. Place timber caps, with ends aligned, in a manner to secure an even and uniform bearing over the tops of the supporting piles. Secure caps by drift bolts at least 3/4 inch in diameter, extending at least 9 inches into the piles. Place the drift bolts approximately in the center of the pile.

G. *Wood Wing and Abutment Backing.* Place wood backing, with horizontal members being level and secured directly to the pile or nailing block. Secure horizontal backing with a minimum of two lag screws, with washers at least 3/8 inches in diameter per pile, extending at least 4 inches into the piles. Place the lag screws approximately in the center of the pile and recess the heads below the top of the sheeting. Use tongue-and-groove lumber for vertical members of wood backing. Place vertical members of wood backing plumb and secured directly to the horizontal backing. Secure vertical backing with a minimum of two lag screws, with washers at least 3/8 inch in diameter, to each of the top two rows of horizontal backing. Place the lag screws so that they extend a minimum of 2 inches into the horizontal backing but do not extend through the horizontal backing.

H. *Bracing*. Bolt bracing through the pile or cap at the ends and at intermediate intersections using a bolt of not less than 5/8 inch in diameter. Use bracing of sufficient length to provide a minimum distance of 8 inches between the outside bolt and the end of the brace.

I. *Stringers*. Size stringers at bearings and place in position so that knots near edges will be in the top portions of the stringers. Join outside stringers with lap joints or butt joints with the ends cut on a taper. Lap-join interior stringers to take bearing over the full width of the floor beam or cap at each end. Securely fasten all stringers by drift bolting. Stagger the joints when stringers are two panels in length. Place cross-bridging or blocking at the center of each span. Frame the cross-bridging between stringers neatly, and toenail securely with at least two nails in each end. Provide full bearing of cross-bridging members, at each end, against the sides of stringers. Cut blocking to a snug-fit condition and secure by nailing.

J. *Plank Decks*. Use planks for decking that are surfaced on four sides. Provide single-plank decks, as required, consisting of a single thickness of plank supported by stringers or joists. Lay the planks heart side down.

1. Lay planks with 1/8 inch openings between them when using seasoned Material, untreated Material, or Material treated with oil-borne preservatives.

2. Lay planks with tight joints when using unseasoned Material or Material treated with water-borne preservatives.

3. Firmly spike each plank to each joist. Lay planks so that no two adjacent planks vary in thickness by more than 1/8 inch. Provide a finished surface that is free of defects.

K. *Glue-Laminated Panel Decks*. Prepare glue-laminated deck panels by pressure-preservative-treatment in accordance with Section 1041.04(A). Apply a preservative treatment to untreated field-cut or drilled areas when it is not possible to complete the fabrication and drilling of members before treating. Plane one side of deck panels only. The top of the deck shall be left rough to ensure proper bonding with bituminous Material. Remove excess oil by absorption prior to paving. Handle and transport glue-laminated deck panels in a way to prevent bending the panels. Support the panels at a sufficient number of points to avoid overstressing, and protect the edges from damage.

L. *Wheel Guards and Railing*. Frame and erect wheel guards, true to line and grade. Use wheel guards, rails, and rail posts that are surfaced on four sides. Lay wheel guards in sections not less than 12 feet long, except where necessary to match expansion joints or end joints. Use horizontal railing members that are smooth and free of splinters in areas where pedestrians will be in proximity to the members.

621.04 Method of Measurement.

A. The Engineer will measure timber and lumber by the thousand feet board measure, MFBM, of each species and grade of lumber and timber listed in the Contract Documents, complete in place and accepted, computed from the actual dimensions and actual lengths. The measurement will include timber in wheel guards.

B. The Engineer will measure glue-laminated girders, beams, and deck panels using the finished cross-sectional dimensions and actual lengths. The Engineer will measure quantities for glue-laminated girders, beams, and deck panels by the thousand feet board measure, MFBM, placed and accepted.

C. The measurement will exclude wood piling, railing, or other Items for which separate payment is provided. The measurement of lumber and timber and of glue-laminated girders and beams includes only such Material as is a part of the completed and accepted Work and does not include Materials used for erection purposes, such as Falsework, bracing, and sheeting.

621.05 Basis of Payment.

A. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
621000	WOOD STRUCTURES, LUMBER	MFBM
621001	WOOD STRUCTURES, TIMBER	MFBM
621002	WOOD STRUCTURES, GLUE-LAMINATED GIRDERS AND BEAMS	MFBM
621003	WOOD STRUCTURES, GLUE-LAMINATED DECK PANELS	MFBM

B. Price and payment constitutes 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.

SECTION 623 – BEARING DEVICES

623.01 Description.

Fabricate, furnish, and install bearing devices.

623.02 Materials.

A. Provide elastomeric bearings, pot bearings, and disc bearings in accordance with Chapter 18 of the specified edition of the *AASHTO LRFD Bridge Construction Specifications*, including Materials, fabrication, and testing.

B. Provide grout in accordance with Section 1047.

C. Provide epoxy grout in accordance with Section 1047.

D. Provide anchor bolts in accordance with Section 1039.

E. Provide dowels in accordance with Section 1037.

F. Provide a waterproof, corrosion-resistant grease for bearings.

623.03 Construction.

A. Working Drawings

1. Design, manufacture, and test bearings in accordance with the specified edition of the *AASHTO LRFD Bridge Design Specifications*.

2. Prepare and submit Working Drawings for the bearings. Such drawings must show all details of the bearings and of the Materials proposed for use, must be sealed by a Professional Engineer registered in the State of Delaware, and must be approved by the Engineer prior to fabrication. Such approval shall not relieve the Contractor of any responsibility under the Contract Documents for the successful completion of Work. The Working Drawings must include, but not be limited to, the following:

   a. The total quantity of each kind of bearing required (fixed, guided expansion, or non-guided expansion), grouped first according to type (load range) and then by actual design capacity.

   b. The plan view and section elevation showing all relative dimensions of each type of bearing.

   c. The maximum design coefficient of friction as noted in the Contract Documents.

   d. The type of Materials to be used for all bearing elements.

   e. If applicable, a clear description and details for any welding process used in the bearing manufacture that does not conform to the approved processes of the specified AASHTO/AWS D1.5 *Bridge Welding Code*.

   f. The vertical and horizontal load, rotation, and movement capacity.

   g. Painting or coating requirements.

   h. Alignment plans.

   i. Installation scheme.

   j. Complete design calculations verifying conformance with the Contract Documents.

   k. Anchorage details.

   l. Bearing preset details, if applicable.

   m. The location of the fabrication plant.

   n. The Manufacturer’s name and the name of the representative who will be responsible for coordinating production, inspection, sampling, and testing.

B. Packaging, Handling, and Storage

1. Prior to shipment from the point of manufacture, package all bearings in such a manner to ensure that during shipment and storage, the bearings will be protected against damage from handling, weather, or any normal hazard.

2. Clearly identify the components of each completed bearing. Securely bolt, strap, or otherwise fasten the components to prevent any relative movement. Mark on its top the location and orientation in each Structure in the project in conformity with the Contract Documents.

3. Store all bearing devices and components at the work site in an area that provides protection from environmental and physical damage. Do not store elastomeric pads in direct sunlight.

4. Do not dismantle bearings at the site unless required by the Engineer for inspection or approved by the Engineer for installation. If dismantling at the site is required, open or dismantle the bearings only under the direct supervision of the Manufacturer's representative.

C. Elastomeric Bearings

1. The Contractor may place elastomeric bearings without external load plates directly on a concrete or steel surface, provided that it is flat to within a tolerance of 0.005 of the nominal dimension for steel reinforced bearings and 0.01 of the nominal dimension for others. Place these bearings within 0.01 radians. Use grout or other directed means to correct any lack of parallelism between the top of the bearing and the underside of the girder that exceeds 0.01 radians.

2. Weld exterior plates of the bearing only if there is 1-1/2 inches of steel between the weld and the elastomer. Subject the elastomer or bond to temperatures less than 390 degrees Fahrenheit.

3. For new structural steel, vulcanize the bearing to the sole plate prior to shipping to the site. For new concrete beams or replacing bearings in the field, use an approved epoxy adhesive to attach the bearings to the beam or sole plate.

4. Use an approved epoxy adhesive to attach the bearing to the bridge seat. Ensure that the bridge seat has been properly cleaned prior to applying the adhesive.

5. Design Steel-reinforced elastomeric bearings using "Method B" in the AASHTO LRFD Bridge Design Specifications, Chapter 14.7.5.

D. Pot and Disc Bearings

1. Install bearings in accordance with the Contract Documents and Working Drawings. Ensure that a technical representative of the bearing manufacturer is on-site for the installation of the first bearing and is readily available to provide guidance for the duration of the installation process.

2. Ensure that the Manufacturer's representative or the Engineer inspects bearing components upon final installation to ensure that they are level and parallel to within 0.03 inch per foot.

3. If the bearings do not meet the tolerances above, submit for approval a plan to correct any deviations.

E. Anchor Bolts

1. Provide swedged or threaded anchor bolts to ensure a secure grip on the Material used to embed them in the holes.

2. Either cast-in-place or grout anchor bolts in preformed sleeved holes. Burr the threads at the face of the nut.

3. Fill the slots and holes in the masonry plates around the anchor bolts with an approved non-hardening caulking compound or elastic joint sealer.

4. When replacing anchor bolts, the existing anchor bolts may be drilled out. Take precautions not to damage any portion of the existing bearing intended for reuse or any of the existing bar reinforcement.

5. Locate anchor bolts to anticipate variation from mean temperature of the superstructure at time of setting. Anticipate lengthening of the bottom chord or bottom flange resulting from dead load after setting, with the intent that, as near as practicable, the anchor bolts at expansion bearings will center their slots at mean temperature and under dead load. Ensure that anchor bolts or nuts allow full and free movement of the superstructure at movable bearings.

F. Cleaning and Greasing Bearings

1. Clean bearings to be greased by high-pressure water flushing at 3000 pounds per square inch.
2. Remove any remaining debris by hand-chipping.
3. Allow bearings sufficient time to fully dry before applying grease.
4. Apply grease at sufficient pressure and rate such that it can cover the contact surface completely. Use only grease that is waterproof and corrosion-resistant and has been approved by the Engineer.
5. Ensure a final film of 1/16 inch minimum on the exposed area of bearings.

623.04 Method of Measurement.

A. Bearing devices will not be measured when incidental to structural steel or concrete beam Items.

B. Bearing devices will be measured as the number of EACH bearing device placed and accepted when not incidental to structural steel or concrete beam Items.

C. Anchor bolts replaced will be measured as the number of EACH anchor bolt removed and replaced and accepted.

D. Cleaning and greasing bridge bearings will be measured as the number of EACH bearing cleaned and greased and accepted.

623.05 Basis of Payment.

A. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
623000	ELASTOMERIC BEARINGS	EACH
623001	POT BEARINGS	EACH
623002	DISC BEARINGS	EACH
623003	REPLACE ANCHOR BOLTS	EACH
623004	CLEAN AND GREASE BRIDGE BEARINGS	EACH

B. Price and payment for bearings constitutes full compensation for furnishing all labor, Materials including lubricant, tools, Equipment, and incidentals and for doing all the Work involved in furnishing, testing, cleaning, lubricating, and installing the bearing devices as specified herein, as shown in the Contract Documents or as directed by the Engineer.

C. Price and payment for replacing anchor bolts constitutes full compensation for furnishing all labor, Materials, tools, Equipment, and incidentals and for doing all the Work involved in furnishing new anchor bolts, removing and disposing of existing anchor bolts, and installing the anchor bolts as specified herein, as shown in the Contract Documents, or as directed by the Engineer.

D. Price and payment for cleaning and greasing bearings constitutes full compensation for furnishing and placing all Materials, for cleaning, for disposing of any debris, and for all labor, Equipment, tools, and incidentals required to complete the Work.

SECTION 624 – JOINTS

624.01 Description.

Fabricate, furnish, and install joints and joint seals.

624.02 Materials. Provide Materials as specified in the following:

Steel	Section 1039
Steel Coating	Section 616
Strip Seal	Section 1042
Closed-cell Joint Seal	Section 1043
Asphaltic Plug Binder Material	Section 1042
Asphaltic Plug Aggregate Material	Section 1042
Silicone Seal	ASTM D5893
Compression Seal	Section 1042

624.03 Construction.

A. Pre-Installation

1. Working Drawings. Prior to beginning any fabrication, submit to the Department for approval a complete set of Working Drawings in accordance with Section 105.04. The submittal must include details and drawings of the steel elements, seals, and all other permanent elements fabricated as part of the joint system. The submittal must also include technical data relating to the joint Material, patching mortar, primer, adhesive, and other related Materials, as well as mill test reports for all steel.
2. Arrange for a manufacturer's representative to be present during the initial installation of the respective joint system. A manufacturer's letter of certification as an approved installer may also be accepted in lieu of having a manufacturer's representative onsite. Qualifying personnel must oversee all operations.

B. Prefabricated Expansion Joint System

1. For rehabilitations, remove existing joint plus enough concrete to properly install the new joint system. Repair concrete in accordance with Section 628 as required.
2. Install the prefabricated expansion joint system, including strip seal, steel extrusion, and application of adhesives, in accordance with the manufacturer's written recommendations and instructions. Provide special tools for insertion of seals as required by the manufacturer.
3. Furnish the strip seal in one piece for the full length of the joint.
4. Unless approved otherwise, shop-assemble the prefabricated sealing system as a unit, including the neoprene strip seal, and preset prior to shipment, using prestressing bolts and adjustable temporary connections between positioning steel members.
5. Initially set the opening of the joint at the width required for the seal at a temperature of 68 degrees Fahrenheit.
6. Position and attach the prefabricated joint assembly to the Structure by anchorages. Make width adjustments at the discretion of the Engineer and manufacturer's representative. Be sure to consider all movements due to temperature, shrinkage, creep, mid-slab deflections, and other factors.
7. Set the prefabricated joint normal to the grade and to the deck concrete slab that will be graded to meet flush with the edge of the joint plates.
8. Before placing the deck slab, release the anchorage attached to the abutment backwall, adjacent steel,

or concrete stringers by loosening the bolts in the slotted anchorage connections. The prestressing bolts and adjustable temporary connections shall remain in place. After the deck slab has cured, check the width of joint again and adjust if necessary.

9. Tighten and weld the released anchorage, and remove the prestressing bolts and temporary connections. The backwall or deck on this side of the joint may then be poured after sealing the openings left by removal of the prestressing bolts.

C. Strip Seal Gland

1. Fully remove the existing strip seal gland and adhesive.
2. Abrasive-blast-clean extrusion to remove all foreign materials. Take care not to damage existing steel extrusions.
3. Install the prefabricated strip seal and apply adhesives in accordance with the manufacturer's written recommendations and instructions and as specified herein. Special tools for insertion of seals shall be provided by the manufacturer as may be required. Ensure that the strip seal gland is fully seated in the steel extrusions.
4. Furnish and install the strip seal in one piece for the full width of the joint.

D. Closed-Cell Joint Seal

1. Prior to ordering the joint Material, measure the joint opening to confirm the required size of the joint Material. If the required size conflicts with the Contract Documents, notify the Engineer immediately.
2. Strictly follow the manufacturer’s recommendations and installation procedures for preparing the surface of the concrete/steel substrates prior to receiving the joint Material and for installing the joint Material.
3. Install the joint Material under a compression of 25 percent. Use the manufacturer’s recommended bonding agent. The bond strength must be greater than the joint material's tensile strength, which is 115 pounds per square inch. (ASTM D3575, Suffix T).
4. All directional changes in joint material must be done using the heat welding method. Place the joint Material ends against a teflon heating iron at 350 degrees Fahrenheit for 10 to 20 seconds. Then place the ends together tightly. DO NOT test the weld until the Material has completely cooled. The Material can be heat welded at the site to increase lengths but not to increase depth or width. However, the Material may be cut down and have grooves applied by a factory representative upon written permission from the manufacturer.
5. Heat welds are not necessary for turns from vertical to horizontal or from horizontal to vertical unless it is necessary to keep the Material flush at these locations. In those areas where the Material must remain flush, the Material may bend to conform to these turns. For vertical turns, the maximum angle is 115 degrees Fahrenheit without having to cut and heat weld the directional turn. For horizontal turns, the maximum angle is 135 degrees Fahrenheit.

E. Asphaltic Plug Joint

1. Provide the following Equipment:
    a. Small self-propelled dry-cut saw;
    b. Pneumatic compressor of 185 cubic feet per minute capacity;
    c. Hot-Compressed Air Lance (HCA Lance) capable of delivering flame-retarded air stream with a temperature of 3,000 degree Fahrenheit and at a speed of 2,950 feet per second;
    d. Rotating vented or un-vented drum-type mixers each with a HCA Lance or a pressure air injection torch (PAT torch);
    e. Double-boiler melter unit that is equipped with agitation and an automatic temperature control that can accurately maintain the Material temperature from 100 to 650 degrees Fahrenheit;

f. Thermometer gauge to monitor the material temperature;

g. Burner system with a safety pilot capable of shutting off the gas supply in the event of a flameout;

h. 100 pound tanks of propane, or smaller;

i. Vibratory roller or plate capable of compacting up to 1 inch in one pass, or as per manufacturer's recommendation;

j. Hand-held, calibrated, digital temperature sensor;

k. Chop saw with carbide blade, if needed;

l. Sandblasting equipment, required only for installation in a concrete overlay;

m. Safety clothing and Equipment as required by OSHA.

n. Any other Material needed in accordance with the manufacturer's recommendations.

2. Prepare the surface of the concrete substrates prior to receiving the joint material and install the joint Material in accordance with the manufacturer's recommendations.

3. Centrally locate the joint over the deck expansion gap or fixed joint. Mark out the joint to the recommended width of 20 inches.

4. Remove the concrete in the joint by the use of saws and pneumatic hand tools. Where possible, set the saws to cut the full-required depth of the wearing surface and any membrane present. Variations in the depth of the wearing surface across the road should be considered to ensure, where possible, that the deck is not damaged. Remove all debris from the excavation channel to allow the full volume of new joint to be installed.

5. Thoroughly clean and dry the entire channel. Remove small debris by using compressed air. Apply the Hot Compressed Air Lance throughout the length of the channel. Installation in concrete overlays requires sandblasting of the concrete vertical walls and adjacent deck area prior to the use of the HCA Lance application.

6. Repair spalled and defective concrete by an approved Material as agreed upon by the Engineer.

7. Install the backer rod and caulk the gap along the backer rod, allowing for approximately 1 inch of binder in the gap on top of the rod. If previous caulking is intact and will hold the binder, it may be used to take the place of the backer rod. Place a small amount of hot binder onto the caulking to ensure that the gap is adequately plugged.

8. Immediately after cleaning and caulking, coat the entire channel with a thin layer of hot binder. If significant delay occurs, the channel shall be inspected by the Engineer to determine if re-cleaning is necessary.

9. Bridge the gap with the steel plates centered over the gap by placing locating pins in the centerline of the plate. There must be at least 2 inches between the edge of the steel plate and the wall of the channel. Ensure that the steel plate sits squarely on the concrete surfaces and does not rock. If necessary, remove additional concrete and build up the joint using patch mortar to the required elevation. Once the locating pins are in place, coat the top of the plate with a thin layer of hot binder.

10. The aggregate must be heated in a vented or un-vented rotating drum mixer by the use of a HCA Lance or a PAT torch. Once the aggregate has been heated to a temperature of 370 to 380 degrees Fahrenheit, coat the aggregate with a small quantity of binder. One gallon of binder per 100 pounds of stone should sufficiently coat the stone.

11. Heat the binder to the recommended pouring temperature of 370 to 385 degrees Fahrenheit. At no time shall the recommended safe heating temperature of 400 degrees Fahrenheit be exceeded.

12. Place layers of hot pre-coated aggregate, not more than 2-1/2 inches thick, in the channel and immediately cover to the level of the coated aggregate. This will ensure that the 3:1 weight ratio of aggregate to binder has been achieved. Layers shall be raked to insure the aggregate is completely

coated and that all air pockets are eliminated. Cease this process approximately 3/4 inch from the top of the channel.

13. Apply the surface layer as other layers except that the pre-coated aggregate is not flooded with binder. Transfer the pre-coated aggregate to the joint and level slightly higher than the adjacent road surface. On a standard 2 inch deep joint, the top-coat should be 1/4 inch higher than the road surface. Deeper joints will require higher levels before tamping.
14. Compaction should take place after the joint has cooled to approximately 225 degrees Fahrenheit. Make the joint surface flush with the existing road surface by using the vibratory plate or roller or as per the manufacturer's recommendation.
15. After compaction, place lines of 4-inch tape 1 inch beyond the joint width on each side of the joint to ensure evenness of appearance. Topcoat the joint and at least 1 inch of the road surface with the hot binder until the surface is smooth and absent of voids. If it is impossible to topcoat the joint during the same working day/night, it is allowable that the topcoat step be completed on the next working day/night. However, the surface must be cleaned, dried, and heated with the HCA Lance.
16. Immediately after top-coating, spread an anti-skid Material evenly over the joint to eliminate Material tracking.
17. Prior to departure, ensure that the entire work area is clean of debris.
18. In the event of a Work stoppage, fill the cavity with cold-patch asphalt in accordance with Section 1015.
19. After curing of the asphaltic joint Material, completely seal the parapet joints along the traffic face of the parapet, following all of the manufacturer's surface preparation and installation procedures.
20. During installation and surface preparation, have qualified personnel on site to oversee and direct the operation for conformance with manufacturer's specifications of both the asphaltic and parapet joint seals.

F. Silicone Seal

1. Remove and dispose of existing joint seal.
2. Sand-blast the steel surfaces of the armor and/or angles to receive the silicone seal to a near-white-metal SSPC-SP10 immediately before the application of the adhesive and installation of the seal to remove all traces of contaminates from the joint faces. Immediately prior to round backer rod installation, blow all joints clean with compressed air. The joint must be thoroughly dry and clean. The round backer rod may be installed by hand, but a roller device shall be used to insure a consistent, uniform placement at the proper depth below the bridge deck surface.
3. Install the silicone sealant as soon after cleaning and round backer rod placement as reasonably possible to insure the joints are still clean and dry. In the event the joint does become contaminated, damp, or wet, remove the round backer rod, clean and dry the joint, and install a new round backer rod.
4. Install the silicone sealant according to the manufacturer's recommendations and to the shape and dimensions shown in the Contract Documents. Any failure of the sealed joint due to lack of adhesion or cohesion of joint Material, improper or unsatisfactory workmanship by the Contractor, or damage by the Contractor's operations or traffic, will be cause for rejection. Repair the joint to the Engineer's satisfaction at no additional cost to the Department.
5. Do not install silicone seal directly on a concrete surface.
6. Ensure that the silicone seal is placed at least 1/2 inch below the riding surface.
7. After a joint has been sealed, remove all excess sealant or other residue on the bridge deck surface. Do not allow traffic on the new seal until the sealant is tack-free and until debris from traffic does not imbed into the sealant.

G. Compression Seal

1. Sand-blast steel surfaces of the armor and/or angles to receive the compression seal to a near-white-metal SSPC-SP10 immediately before the application of the adhesive and installation of the seal.
2. Perform all welding and steel cutting Work in accordance with the applicable requirements of Section 615 of the Standard Specifications.
3. All concrete surfaces to receive compression seal shall be free from dirt, oil, rust, and any other loose foreign debris that may be detrimental to effective joint sealing. Repair spalls and cracks with patch mortar to form a clean joint opening with sharp edges.
4. Follow the manufacturer's recommendations in surface preparation, application of adhesive, and installation of the compression seal. Ensure that the compression seal is placed at least 1/2 inch below the riding surface. If any contradictions are found between these specifications and the manufacturer's recommendation, the latter will prevail.

624.04 Method of Measurement.

The quantity of joints will be measured as the number of linear feet of joints fabricated, installed, and accepted.

624.05 Basis of Payment.

A. The Engineer will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
624000	PREFABRICATED EXPANSION JOINT SYSTEM, 3"	LF
624001	PREFABRICATED EXPANSION JOINT SYSTEM, 4"	LF
624002	PREFABRICATED EXPANSION JOINT SYSTEM, 5"	LF
624003	STRIP SEAL GLAND, 1 1/2"	LF
624004	STRIP SEAL GLAND, 2"	LF
624005	STRIP SEAL GLAND, 3"	LF
624006	STRIP SEAL GLAND, 4"	LF
624007	STRIP SEAL GLAND, 5"	LF
624008	CLOSED-CELL JOINT SEAL	LF
624009	ASPHALTIC PLUG JOINT	LF
624010	SILICONE JOINT SEAL, 1"	LF
624011	SILICONE JOINT SEAL, 2"	LF
624012	SILICONE JOINT SEAL, 3"	LF
624013	COMPRESSION SEAL, 1"	LF
624014	COMPRESSION SEAL, 2"	LF
624015	COMPRESSION SEAL, 3"	LF
624016	COMPRESSION SEAL, 4"	LF

B. Price and payment for prefabricated expansion joint system constitutes full compensation for removing and disposing existing joint system and adjacent concrete, and fabricating, furnishing, and installing all Materials, labor, Equipment, tools, and incidentals necessary to complete the Work. Payment for erection angles and other components not specifically part of the prefabricated strip seal joint system will be included in prefabricated expansion joint system.

C. Price and payment for strip seal constitutes full compensation for removing and disposing existing seal, cleaning existing extrusions, furnishing and installing all Materials and for all labor, Equipment, tools, and incidentals required to complete the Work.

D. Price and payment for closed-cell joint constitutes full compensation for pre-measuring, furnishing and placing all Materials, cleaning and preparing the joint as per manufacturer's recommendations, and for all labor, Equipment, tools, and incidentals necessary to complete the Work.

E. Price and payment for asphaltic plug joint constitutes full compensation for pre-measuring, furnishing and placing all Materials including cold patch Material, cleaning and preparing the joint as per manufacturer's recommendations, sealing the parapet joints, and for all labor, Equipment, tools, and incidentals necessary to complete the Work.

F. Price and payment for silicone seal constitutes full compensation for removing and disposing existing seal, furnishing and placing all Materials, cleaning and preparing the joint, and for all labor, Equipment, tools, and incidentals necessary to complete the Work.

G. Price and payment for compression seal constitutes full compensation for removing and disposing existing seal, furnishing and placing all Materials, cleaning and preparing the joint, repairing spalls and sealing cracks to form a clean joint opening, and for all labor, Equipment, tools, and incidentals necessary to complete the Work.

H. Price and payment for concrete removal and repair beyond what is required for the installation of the joint system will be paid under the respective concrete repair Item.

SECTION 625 – CONCRETE OVERLAYS

625.01 Description.

Furnish Materials and construct concrete overlay on concrete deck surfaces where shown in the Contract Documents or as directed by the Engineer.

625.02 Materials. Provide Materials as specified in the following:

Latex-Modified Concrete (LMC)	Section 1046.01
Microsilica-Modified Concrete (MSMC)	Section 1046.02

625.03 Construction. Submit for approval, a minimum of 5 years of documented history with experience in the use and placement of the intended overlay material. A manufacturer's letter of certification as an approved installer may also be accepted. Qualifying personnel must oversee all operations.

A. Latex-Modified or Microsilica-Modified Concrete

1. Pre-placement Meeting

a. Schedule a pre-placement meeting with the Engineer at least 15 Days in advance of placing the overlay. The meeting will discuss the plan and procedure for the Work and will acceptably establish the Contractor's ability to place the overlay on a continuous basis and to consolidate, finish, texture, and commence curing within the time intervals specified. If placement of the overlay is to be made at night, the meeting will also discuss the Contractor's plan to provide adequate lighting for the work area.

b. Submit to the Engineer for review and conformance, all Equipment to be used for surface preparation, mixing, placing, and finishing the latex- or microsilica-modified concrete prior to the pre-placement meeting. This Equipment includes the following:

i. Power-driven scarifier;

ii. Chipping hammers (maximum nominal 15 pound class);

iii. Abrasive blaster;

iv. Overlay mixer-trucks (MSMC only);

v. Proportioning and mixing Equipment (LMC only);

vi. Mechanical fogger; and

vii. Finishing machine.

c. Use an approved finishing machine complying with Section 610.03(E)(4)(c)(i) and having a vibrating pan to properly consolidate the mix.

d. For latex modified concrete use proportioning and mixing Equipment that is a self-contained, mobile, continuous mixing-type subject to the following:

i. The mixer must be self-propelled and be capable of carrying sufficient unmixed dry, bulk cement, sand, coarse aggregate, latex modifier, and water to produce on the site not less than 6 cubic yards of modified Portland Cement Concrete.

ii. The mixer must be capable of positive measurement of cement being introduced into the mix. A recording meter must be visible at all times, and equipped with a ticket print-out to indicate the quantity.

iii. The mixer must provide positive control of the flow of water and latex emulsion into the mixing chamber. Water flow must be indicated by a flow meter and be readily adjustable to provide for minor variations in the moisture of the sand and aggregate.

iv. The mixer must be capable of being calibrated to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis as required by the finishing operation, and it must discharge mixed material through a conventional chute directly in front of the finishing machine.

v. The mixer must be capable of spraying water over the entire placement width as it moves ahead to insure that the surface to be overlaid is wetted prior to receiving the latex concrete.

vi. The mixer must be calibrated to accurately proportion the specified mix. Certification of the calibration by an approved testing laboratory or by the Department will be accepted as evidence of this accuracy if the yield is shown to be true within a tolerance of 1.0 percent according to the following test:

A) With the cement meter set on zero and all controls set for the desired mix, activate the mixer discharging mixed Material into a 0.25 cubic yard container – 36 inches x 36 inches x 9 inches.

When the container is level-struck full, making provision for settling the Material into all corners, the cement meter must show a discharge of 1.875 bags of cement.

2. Surface Preparation

a. For decks and approach slabs with existing overlays, mill off the existing overlay. After this initial removal, sound the deck and outline areas of unsound concrete for removal, subject to the approval of the Engineer. Removal and repair Work below the initial milling will be measured and paid for under their respective pay Items. On any bridge decks or approach slabs where a hot mix surface is removed and no additional concrete milling is specified, scarify the exposed concrete surface an additional 1/8 inch to 1/4 inch in depth to remove all hot mix laitance prior to sounding the concrete as specified above and final cleaning as specified below.

b. Thoroughly shot-blast or grit-blast the areas to receive the overlay not more than 24 hours before placement begins. Blast-clean the edge of any previously placed lanes of overlay to remove the trowel-cut surfacing to promote bond. If necessary to remove rust, oil, or other foreign materials detrimental to achieving bond, detergent-cleaning followed by shot- or grit-blasting and air-blast-cleaning may be performed.

c. Immediately prior to placement of concrete, thoroughly hose down the clean surface with water and keep wet for a period of at least one hour for latex-modified concrete and at least six hours for microsilica-modified concrete. Use compressed air, free of oil, to blow out any standing water in depressions, holes, or areas of concrete removal. Take all necessary precautions with the deck preparations to ensure a good bond with the overlay.

d. Saw straight and vertical edges to transverse and longitudinal joints of previously placed overlay before overlay is placed against them.

e. Prevent contamination of the cleaned and wetted deck by placing a clean 4 mil (minimum) thick polyethylene film (or other covering as approved by the Engineer) that completely covers the surface of the deck to be overlaid.

3. Limitations of Placing Overlay Concrete

a. The Contractor is responsible for the quality of the concrete placed in any weather or atmospheric conditions. A smooth, durable riding surface of uniform texture, true to the required grade and cross-section, must be obtained on all Bridge decks.

b. Do not place the overlay concrete when rain is forecast within the intended working period. Make adequate preparations to provide protection of the freshly placed overlay in the event of sudden or unexpected rain. If rain occurs during placing of the overlay, immediately cease all operations other than protection of the already placed overlay. Replace Materials damaged by the rain at no additional cost to the Department.

c. Place the overlay concrete only when the local ambient temperature is above 45 degrees Fahrenheit for the entire curing period. Do not place the overlay if the ambient air temperature is 85 degrees Fahrenheit or higher or predicted to go above 85 degrees Fahrenheit during the overlay placement regardless of the surface evaporation rate. The overlay concrete must not exceed 85 degrees Fahrenheit.

d. Place the overlay concrete only if the overlay surface evaporation rate, as affected by ambient air temperature, concrete temperature, relative humidity, and wind velocity, is 0.15 pounds per square foot per hour or less. Determine and document the atmospheric conditions, subject to verification by the Engineer. Use the chart contained in "Plastic Cracking of Concrete" by Delmar Bloem for the National Ready Mixed Concrete Association and published in ACI 305 to determine the loss of surface moisture for the overlay. The chart may be obtained from the Department's Materials and Research Section.

e. Do not place an overlay adjacent to a previous overlay that has cured for less than 3 cure-days.

4. Mixing of Materials

a. Latex-Modified Concrete

i. Mix the latex-modified concrete in accordance with the applicable provisions of Section 1046.

ii. Thoroughly mix the overlay concrete in an approved, thoroughly clean mixer at the site. Add the accurately proportioned ingredients to the mixer in accordance with the recommendations of the manufacturer of the latex modifier.

iii. Do not place into the mix, bags or other containers holding ingredients, including those identified by the manufacturer as dissolving or breaking up during mixing.

iv. Use minimum mixing time to secure the air content and slump desired, and in accordance with the recommendations of the manufacturer of the latex modifier.

v. The overlay concrete must be uniform in composition and consistency when discharged from the mixer. Mixing capacity must be such that finishing operations can proceed at a steady pace with final finishing operations completed before the formation of the plastic surface film.

b. Microsilica-Modified Concrete

i. Centrally batch the overlay and mix in a central mixing plant or by mixer-trucks capable of producing a workable mixture of uniform composition and consistency. Use batching and mixing Equipment in accordance with Section 1022.

ii. Introduce admixtures into the concrete in such a manner that will disperse them throughout the entire load.

iii. Limit the mixer-truck charge to a maximum of 75 percent of its rated capacity or to 6 cubic yards, whichever is smaller.

iv. Do not place into the mix, bags or other containers holding ingredients, including those identified by the manufacturer as dissolving or breaking up during mixing.

v. Air entrainment and slump of the first Material delivered to the deck will be determined by the Engineer. Do not place the overlay until acceptability of the production has been verified.

5. Placement

a. Place overlay concrete in accordance with Section 610. The maximum overlay thickness per lift is 2-1/2 inches.

b. The maximum time allowed between the start of mixing to the completion of discharge of the overlay concrete at the worksite is sixty minutes.

c. For microsilica-modified concrete, do not exceed a maximum water-cement ratio of 0.40. Mix any admixture added at the job site a minimum of 5 minutes or 30 revolutions. After all

components have been added, the slump range must be 6 inches ± 2 inches. If a slump loss occurs after mixing and before placement of the overlay, the charge may be "re-tempered" with the high-range, water-reducing admixture to restore plasticity; re-tempering with water will not be allowed. The slump and air content will be rechecked to ensure conformance to the Specifications. If the consistency of the charge after "re-tempering" is such as to cause segregation of the components, this will be cause for rejection of the load. The overlay Material must still be placed within the original 60-minute limitation or it will be rejected.

d. Immediately before the overlay is placed, clean the concrete surfaces with an air-blast (oil-free), clear of any standing water, and then cover with a coating of bonding grout consisting of the overlay placed and brushed onto the deck. Remove the coarse aggregate from the deck. Place the overlay only when the existing deck is "surface dry." Scrub the grout onto surface-dry decks (surfaces that are dry enough to absorb some of the moisture from the grout with enough care to ensure that all surfaces are evenly covered and that excess grout will not collect in low areas). Apply the bonding grout for only a short distance in advance of the placement of the overlay. Reapplication is required when the grout dries prior to overlay placement.

e. The maximum allowable time between the discharge and the final finishing of the overlay concrete is ten minutes.

f. Install a construction dam or bulkhead in case of a major delay in the placement operation exceeding one hour in duration. During minor delays of one hour or less, the end of the placement may be protected from drying with several layers of wet burlap.

g. If overlay concrete placement is stopped or delayed for a duration of 90 minutes or more, discontinue further placement until after a period of not less than 12 hours. This restriction does not prohibit continuation of placement provided a gap is left in the lane. The gap must be sufficient in length for the finishing machine to clear the previously placed overlay concrete.

6. Consolidating and Finishing

a. Immediately following application of the bonding grout, place the overlay, consolidate, and finish, with vibrating devices, to the grades shown in the Contract Documents. Spud vibration is required in deep pockets, edges, and adjacent to joint bulkheads. Hand-finishing with a float may be required along the edge of the pour or on small areas of repair. Edge-tooling is required at joints, except next to metal expansion dams, curbs, and previously placed lanes.

b. Use a 10 foot straightedge to check the overlay directly behind the finishing machine and transversely along the edges of the overlay where hand-finishing is done. Immediately correct any irregularities exceeding 1/4 inch in 10 feet. Correct any ponding problem that is noted prior to Final Acceptance of the overlay, at no cost to the Department. Test the overlay concrete surface for smoothness in accordance with Section 610.

c. For microsilica-modified concrete, if needed, a water fog may be applied by the use of mechanical fogging Equipment attached to the paving machine to achieve an atomized water mist/fog above, but not on, the surface of the overlay concrete. Discharge the water fog at high velocity by the airstream of the mist-blower. Do not use hand-pump sprayers for the spraying.

7. Curing

a. As soon as the finishing operation is completed and within twenty minutes after initial concrete discharge, cover the finished overlay surface with a layer of clean, fully wet, saturated burlap and with a 4 mil (minimum) thick white opaque polyethylene film. For a period of 7 cure-days (a cure-day is defined as a 24-consecutive-hour period of time), keep the burlap wet by the continuous application of water through soaker hoses. After the 7 day cure period, remove the polyethylene and burlap and apply curing compound in accordance with Section 610.

b. Maintain the temperature at the overlay surface above 35 degrees Fahrenheit until the curing period is completed. Any day during which the air temperature at the overlay surface falls below 45 degrees Fahrenheit will not be counted as a cure-day.

c. Seal or repair any cracking that occurs prior to opening to traffic in a manner approved by the Engineer at no cost to the Department. Sound the deck and remove and replace any delaminated areas at no cost to the Department.

d. Texture the surface in accordance with Section 610.

e. Any improperly cured overlay is subject to replacement at no cost to the Department.

625.04 Method of Measurement.

Concrete overlays will be paid separately at the Contract Unit Price for furnishing and installation of the respective overlay.

625.05 Basis of Payment.

A. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
625000	LATEX-MODIFIED CONCRETE OVERLAY INSTALLATION	SY-IN
625001	FURNISHING LATEX-MODIFIED CONCRETE OVERLAY	CY
625002	MICROSILICA-MODIFIED CONCRETE OVERLAY INSTALLATION	SY-IN
625003	FURNISHING MICROSILICA-MODIFIED CONCRETE OVERLAY	CY

B. Price and payment for furnishing all Materials is to be paid separately.

C. Price and payment for installation of the overlay Material constitutes full compensation for the preparation of the area to receive overlay including scarifying, shot- or grit-blasting, removal of rust, oil, and other contaminants, protecting the area, placing the bonding grout or primer coat, placing of concrete overlay, consolidating, curing, texturing, constructing, and removing test patches, and for all labor, Equipment, tools, and incidentals necessary to complete the Work.

SECTION 626 – METAL RAILINGS

626.01 Description.

Fabricate, furnish, and install metal railings.

626.02 Materials. Provide Materials as specified in the following:

Steel	Section 1039
*If galvanized steel is used, galvanize after fabrication.	
Aluminum	Section 1044
Elastomeric Pads	See below
Anchor Bolts	Section 1039

Provide elastomeric pads in accordance with Chapter 18 of the specified edition of the *AASHTO LRFD Bridge Construction Specifications*, including Materials, fabrication, and testing.

626.03 Construction.

A. Working Drawings

1. Prepare and submit Working Drawings for the metal railings. Such drawings must show all details of the railings and of the Materials proposed for use, must be sealed by a Professional Engineer registered in the State of Delaware, and must be approved by the Engineer prior to fabrication. Such approval shall not relieve the Contractor of any responsibility under the Contract Documents for the successful completion of Work.

B. Packaging, Handling, and Storage

1. Handle, pack, ship, and store the Materials in such a manner as to minimize damage to the finish. When applicable, or when requested by the Engineer, supply one-half pint of suitable touch-up Material to the Department.

2. Carefully handle railing and incidental parts and store on blocking, racks, or platforms to prohibit contact with ground. Protect the railing and incidental parts from corrosion or damage. Keep the Materials free from dirt, oil, grease, and other foreign matter. Repair or replace damaged Material as directed by the Engineer at the Contractor's Expense.

C. Installation

1. Set each post base on a preformed elastomeric pad. The outline of the pad shall conform to the base of the post or base plate. Set all posts normal to grade and all rails parallel to grade, unless otherwise noted in the Contract Documents.

2. Set anchor bolts prior to pouring the concrete being anchored into and firmly hold the anchor bolts in place by a template. Apply a protective coating of grease or oil to the portions of anchor bolts exposed above the concrete before the concrete is poured.

3. After the concrete is cured, install handrails as shown in the Contract Documents.

4. For coated railings, no paint will be required on the completed installation except for any touch-up of damaged coating. Coat such damaged areas with a material acceptable to the Engineer. Before acceptance of the installation, thoroughly clean the railing of all dirt, grime, and stains. Use cleaning methods and agents in accordance with the recommendations of the rail manufacturer.

5. Place rails after Falsework for the span has been released, rendering the span self-supporting. Construct the rails true to the line and grade specified. This may include an allowance for camber in each span, but do not follow any unevenness in the superstructure.

6. Fabricate formed sections of steel rail from mild steel. Pipe sections may be of standard steel pipe. Finish exposed welds by grinding or filing to give a smooth surface. Weld aluminum Materials by inert gas-shielded, electric, arc-welding process using no welding flux. Cut aluminum by means other than torch or flame-cutting.
7. Adjust metal rails before anchoring to ensure proper matching at abutting joints, correct alignment, and camber throughout their length. Drill holes for field connections with the rails in place and at proper grade and alignment.
8. Coat surfaces in areas that aluminum alloys come in contact with other metals or concrete, with a dielectric aluminum-impregnated caulking compound, or place a synthetic rubber gasket between the two surfaces.
9. Galvanize anchor bolts, nuts, and all steel portions of rails. Leave aluminum portions unpainted. Repair minor abrasions to galvanized surfaces with zinc-rich paint.
10. Grind smooth all rough or sharp corners that would endanger either during fabrication or after erection. Burr all anchor bolts and other connecting bolts and fasteners to prevent loosening after erection is completed.

626.04 Method of Measurement.

Metal railings will be measured as the number of linear feet fabricated, placed, and accepted.

626.05 Basis of Payment.

A. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
626000	STEEL PEDESTRIAN RAILING	LF
626001	STEEL HAND RAILING, TYPE 1	LF
626002	STEEL HAND RAILING, TYPE 2	LF
626010	ALUMINUM PEDESTRIAN RAILING	LF
626011	ALUMINUM HAND RAILING, TYPE 1	LF
626012	ALUMINUM HAND RAILING, TYPE 2	LF

B. Price and payment will constitute full compensation for furnishing, fabricating, and installing all Materials; for repair of any damaged Materials; for touch up of damaged coatings; and for all labor, Equipment, tools, and incidentals required to complete the Work.

SECTION 628 – CONCRETE REPAIR AND REHABILITATION

628.01 Description.

Furnish all Materials and repair or rehabilitate concrete Structures.

628.02 Materials. Provide repair Materials as specified in the following:

Epoxy Injection System	ACI 503.7-07
Epoxy Bonding Agent	ASTM C881
High Molecular Weight Methacrylate Crack Sealer	Section 1045
Low- or Medium-Modulus, Neutral-Curing, Silicone Crack Sealant	ASTM C920
Grout	Section 1047
Epoxy Grout	Section 1047
Concrete	Section 1022; Section 1023

628.03 Construction. Submit for approval, a minimum of 5 years of documented history with experience in each of the respective repair and rehabilitation operations and use of any specific manufactured products being proposed. A manufacturer's letter of certification as an approved installer may also be accepted. Qualifying personnel must oversee all repair and rehabilitation operations.

At least ten (10) Days prior to the start of Work, conduct a meeting to brief the personnel performing the Work and the Engineer on the operations. Submit for review and comment, formal Meeting Minutes or Concrete Repair Work Plan to document the Contractor's proposed means and methods discussed during the preconstruction meeting.

A. Epoxy Injection

1. Cracks shall be a minimum of 1/16 inch to a maximum of 1/4 inch wide. Install injection ports or tees spaced at 6 inches to 12 inches for vertical repairs and 6 inches to 18 inches for horizontal repairs, but in no case closer together than the thickness of the concrete member if full-depth penetration is desired. However, in certain cases, depth and spacing of holes at injection ports or tees can be established with due consideration of the crack widths and depths compatible with flow characteristics of the epoxy and injection pressure to ensure that no further damage will be done to the member being repaired.

2. Set ports or tees in dust-free holes made either with vacuum drills or chipping hammers. After injection ports or tees have been inserted into the holes, seal all surface cracks in the area to be repaired with epoxy binder between ports to ensure retention of the pressure-injected epoxy within the confines of the member. Limit the application of epoxy binder to clean and dry surfaces and substrate temperatures to not less than 50 degrees Fahrenheit during epoxy application. Grind down the injection ports or tees flush with the exposed concrete surface once the epoxy binder hardens as per manufacturer's recommendations. Provide a neat-looking concrete surface once the epoxy binder hardens, which may require grinding.

3. Follow the manufacturer's recommendations for surface preparation, mixing of the components of the injection epoxy system, and all other works. If there is conflict between these Specifications and the manufacturer's recommendations, the latter will prevail.

B. Deck, Approach Slab or Sidewalk Crack Sealing

1. Become aware of and follow the Manufacturer's safety precautions of all Materials and exercise appropriate measures. Equipment used for cleaning and preparing the surface areas and for the application of the crack sealer is subject to approval prior to their use.

2. Prior to the application of the crack sealing Material, clean the concrete surfaces in accordance with the Manufacturer's recommendations. This will involve removal of all traces of dust, dirt, salt, grease, oil, curing compounds, waxes, asphalt, laitance, and all other foreign contaminants. Ensure that the

substrate is clean, sound, and free of surface moisture prior to application. Closely monitor the surface preparation to avoid any unnecessary surface damage. Surface preparation is subject to final approval by the Engineer.

3. Apply the crack sealing Material within the ambient temperature range as recommended by the Manufacturer, when no rain is expected within a minimum of two hours following the application, and when there are no high winds that would cause an improper application. If rain has preceded the application, allow the surface to dry at least 24 hours before the application of the crack sealer begins.
4. If excess sealing Material is on the surface after the crack sealing treatment has been completed, cover the area with a light broadcast of a dry sand meeting the requirements of Section 1003. Use only an amount of sand that is sufficient to absorb the excess Material. The time of sand broadcast shall be in accordance with the manufacturer's recommendation.
5. Keep traffic off the treated surface until the crack sealing Material has been completely absorbed and the surface is dry in accordance with the manufacturer's recommendation.
6. Perform surface preparation and application of the crack sealing material so as not to endanger any private and/or public property, pedestrians, workmen, marine traffic, and vehicles on, beneath, or adjacent to the structure.

C. Rout and Seal Cracks

1. Do not proceed with installation of joint sealants under the following conditions:
   a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 degrees Fahrenheit.
   b. When joint substrates are wet.
   c. When joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
2. Examine joints indicated to receive sealant, with installer present, for compliance with requirements for joint configuration, profile, and other conditions affecting joint-sealant performance. Proceed with installation only after unsatisfactory conditions have been corrected and approved.
3. Rout joints as per manufacturer's recommendations, which include the recommended joint depth and width to be routed.
4. After routing operations are complete and immediately prior to installing joint sealant, clean out joints to comply with joint sealant manufacturer's written instructions and the following requirements:
   a. Remove all foreign material from joint substrate that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), oil, grease, waterproofing, water repellants, water, surface dirt, and frost.
   b. Clean porous joint substrate surfaces by brushing, grinding, blast-cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles from the above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
5. Prime joint substrates as per the joint sealant manufacturer's recommendations, based on preconstruction joint sealant substrate tests, or prior experience. Apply a primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
6. Install joint sealant in according to the manufacturer's instructions and the following:
   a. Place sealants so they directly contact and fully wet joint substrates.
   b. Completely fill recesses provided for each joint configuration.
   c. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum

sealant movement capability.

7. Immediately after sealant application and before skinning or curing begins, tool non-sag sealant according to the following requirements to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint:

   a. Remove excess sealants from surfaces adjacent to joint.

   b. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

   c. Provide concave joint configuration per Figure 5A in ASTM C1193, unless otherwise indicated.

8. Clean off excess sealants or sealant smears adjacent to joints as the work progresses by methods and cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

9. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work. This removal and reinstallation shall be at no additional cost to the Department.

D. Repair of Existing Grout

1. Section 628.03(D) applies to the repair of non-shrink grout used to fill shear keys between precast concrete elements or various pockets and voids associated with precast concrete elements.

2. Remove deteriorated grout in accordance with Section 628.03(E)(4). Take care not to damage the adjacent precast concrete elements. Repair any damage to sound precast concrete in accordance with Section 628.03(E) and at no cost to the Department.

3. After removal of deteriorated grout is complete, clean concrete surface in accordance with Section 628.03(E)(5).

4. Wet the concrete surfaces prior to placement of grout. Do not allow any standing water to remain in the area to receive grout. During grout placement, prevent any falling Material from reaching the roadway, waterway, or railroad area below. Prepare, place, and cure in accordance with the manufacturer's recommendations.

E. Spall and Delamination Repair

1. Shallow spalls are defined as patches that do not extend below the top mat of reinforcement. Deep spalls are defined as patches that extend below the top mat of reinforcement. Rehabilitation of PCC masonry is defined as deep-spall patches that exceed the 1.0 cubic yard threshold in a single area. Section 628.03(E) does not apply to elements that are prestressed or whose performance relies primarily on post-tensioning.

2. Submit for review and approval, details for deep spall repair or rehabilitation of locations under water or within the splash zone.

3. Saw cut the edges of the area to be repaired back sharp, perpendicular to the face of the concrete to at least 1 inch deep, taking care not to damage any reinforcing bars. The saw cut area must be squared with a minimum of a 6-inch buffer between the saw cut and the visibly spalled, disintegrated, delaminated, deteriorated, loose, and/or honeycombed concrete.

4. Remove all spalled, disintegrated, delaminated, deteriorated, loose, and honeycombed concrete. Collect all debris and prevent any falling Material from reaching the roadway, waterway, or railroad area below. All removed material shall become the property of the Contractor and shall be removed from the site and disposed in accordance with Section 106.08.

   a. For shallow spall, remove to above the top of the reinforcement bar. Use a 15 pound pneumatic

hammer unless otherwise noted in the Contract Documents. Alternative tools will be permitted upon approval by the Engineer. Do not remove concrete below top of reinforcement unless approved by the Engineer.

b. For deep spall and rehabilitation of Portland Cement concrete masonry, remove to a sound concrete surface to a minimum of 1 inch behind the existing reinforcement. Take care not to damage the existing reinforcement. Use a 15 pound pneumatic hammer for the superstructure or a 30 pound pneumatic hammer for the substructure unless otherwise noted in the Contract Documents. Alternative tools will be permitted upon approval by the Engineer. Limit removal at any one location as noted in the Contract Documents and as the Engineer deems necessary due to field conditions. If due to field conditions, removal of deteriorated concrete includes any bearing seat not specified in the Contract Documents or any area meeting the threshold for rehabilitation of Portland Cement concrete masonry not specified in the Contract Documents, notify the Engineer immediately. Do not resume Work in these areas until approval has been obtained from the Engineer.

5. Clean and prepare the concrete surface area in accordance with the manufacturer specifications.

6. For deep spall and rehabilitation of Portland Cement concrete masonry, in case of damaged rebar due to construction activities, lap-splice, cut, and mechanically splice, or replace the damaged rebar with a new bar of the same size. Ensure the ends are lapped or mechanically coupled to the ends of the existing rebar to the satisfaction of the Engineer. There will be no separate payment for such Work, and the cost will be included in the Item. Refer to Section 628.03(E)(7) for further guidance on type and size of the new rebars, minimum lap/splice lengths, and any necessary modifications to the limits of the repair area.

7. For deep spall and rehabilitation of Portland Cement concrete masonry, clean to bright metal (black bars only) or visible epoxy coating (epoxy-coated bars only) by removing rust, coatings, or any foreign material using grit-blast, wire-brushing, or other approved means. Apply epoxy coating at all areas of the existing epoxy-coated reinforcing steel that exhibits flaked or scratched surfaces. Care must be taken not to epoxy-coat the concrete surface beyond the bars. It is not necessary to coat existing black bars. Place new epoxy-coated reinforcement bars to supplement an existing reinforcement bar when an existing bar has a section loss of 20 percent or more of the original cross section, as determined by the Engineer, or when the existing reinforcement bar is broken. Use new bar of the same cross-sectional area as the existing bar and extend 30 bar diameters in each direction from where the section loss or breaks ends. Dual bars of equivalent or greater section may be used. The Engineer will be the sole judge as to which bars are in need of repairs. Where the bond between existing concrete and reinforcing steel has been destroyed, remove the concrete adjacent to the bar to a depth that will permit concrete to bond to the entire periphery of the bar so exposed. Exercise care to prevent cutting, deforming, or damaging any exposed reinforcing steel. Modify the limits of the repair area to meet the reinforcement splice lap or mechanical coupler requirements.

8. All operations, including, but not limited to, the surface preparation, mortar application, and restrictions of the mortar prepared for repair Work, will conform to the manufacturer's recommendations. The finish of the repaired area shall match the existing concrete surfaces and architectural details. Make the depth of repair as noted in the Contract Documents; however, such dimension may change in field if the Engineer deems it necessary.

9. For shallow spall repairs, apply the patch mortar in lifts of no more than 2 inches or as recommended by the manufacturer. Hand-trowel the top application of patch mortar to obtain a smooth, final surface.

10. For deep spall and rehabilitation of Portland Cement concrete masonry, apply concrete in accordance with Section 610.

    a. For deep spall, pneumatically applied mortar and quick setting Material may be substituted for Class A mix design upon approval of the Engineer with an exception of bridge seat areas. Use Class A Concrete, or approved equal, for any spall depths greater than 6 inches.

b. For rehabilitation of Portland Cement concrete masonry, use Class A Concrete or approved equal.

c. Apply an approved bonding agent to the existing concrete prior to placing concrete when using Class A concrete.

d. Do not allow concrete to drop from the top of the forms that could otherwise result in the separation of the mix. Use only approved mixing and placing Equipment in the preparation and handling of the concrete. Remove all oil and other rust-inhibitors from all Equipment in contact with the concrete before the mixes are used.

11. For deep spall and rehabilitation of Portland Cement concrete masonry, if present, expansion or contraction joints are to be formed in the concrete repair Material at the location of the existing joints.

F. Deck Repair

1. Section 628.03(F) applies to deck repairs of a concrete riding surface or of a milled concrete surface that will receive an overlay.

2. Incorporate in the Concrete Repair Work Plan the means and methods intended for protecting and curing the patches. When Contract time constraints do not permit curing times as specified in Section 610, the Contractor's plan must also detail what methods and/or Materials he/she will use to attain the necessary early strength and open it to traffic in a timely manner.

3. Take precautions to assure that traffic is protected from rebound, dust, and construction activities. Provide appropriate shielding as required and directed by the Engineer.

4. Before any patching is commenced, the Engineer will inspect the entire deck surface or, when a mill and overlay is utilized, the entire exposed portion of the deck surface, and indicate the type and extent of repair, if any, that is to be made.

5. Saw cut in accordance to Section 628.03(E)(3) except that the minimum depth of vertical face will be 1/2 inch. Keep areas from which unsound concrete has been removed free of slurry produced by additional wet sawing of concrete. Plan Work so that this slurry will drain away from all open areas. Remove all such slurry from prepared areas before patch is placed.

6. Remove deteriorated areas of deck down to sound concrete in accordance to Section 628.03(E)(4). Do not operate mechanical chipping tools at an angle in excess of 45 degrees measured from the surface of the deck.

7. When the depth of removal of an existing concrete deck spanning over a roadway, waterway, or railroad reaches 1/2 of the existing concrete deck thickness and deeper removal is anticipated, furnish and erect temporary protective Structures under the deck to prevent any falling Material from reaching the roadway, waterway, or railroad area below.

8. After removal of deteriorated concrete is complete, clean concrete surface in accordance with Section 628.03(E)(5).

9. Refer to Section 628.03(E)(6) for further guidance in an event of damaged rebar due to construction activities.

10. Refer to Section 628.03(E)(7) for further guidance on any necessary cleaning of existing reinforcement and the need to repair or replace existing reinforcement.

11. Patch spalled concrete, voids, and other defects in accordance with the following:

a. For cavities less than 1/2 inch in depth on milled surfaces, no special treatment of cavity is required.

b. For cavities less than 1/2 inch in depth on riding surfaces, chip down the perimeter of the patch so that a 1/2 inch minimum depth vertical face from the top of the adjacent deck surface exists and fill the space with epoxy grout.

c. For cavities 1/2 inch to 1 inch in depth, fill the space with epoxy grout.

d. For cavities 1 inch to 3 inches in depth, Contractor has the option of using epoxy grout or Class D mix concrete. If epoxy grout is used, place patch in layers not to exceed 1-1/2 inches in depth. Contractor may use one or more of any patching Material specified, provided that the total depth of each patch is made with only one type of patch Material.

e. In areas where the depth of removal of deck material is over 3 inches in depth, place Class D concrete up to the concrete deck surface.

12. When the deck is to receive an overlay, shot- or grit-blast the surfaces of patches repaired with epoxy grout to assure proper bonding with the overlay. For riding surface repairs, apply a broom or hand-tine finish.

G. Drilling Holes and Placing Dowels

1. Drill holes at the locations and to the minimum depth shown in the Contract Documents. Drill hole diameters in accordance with the epoxy grout manufacturer's recommendations considering the size(s) of the dowels or as shown in the Contract Documents. Grout the anchor bolts or dowels in place using the epoxy grout in a manner to complete bonding of the anchor bolts or dowels in the holes and in accordance with manufacturer's recommendations. Repair any damage caused by the drilling operations to the satisfaction of the Engineer at no additional cost to the Department.

628.04 Method of Measurement.

A. The quantity of epoxy injection will be measured as the actual number of linear feet of cracks injected and accepted.

B. The quantity of deck, approach slab, or sidewalk crack sealing will be measured as the actual number of square feet of surface area placed and accepted or the actual number of linear feet of cracks sealed and accepted.

C. The quantity of rout and seal cracks will be measured as the actual number of linear feet of cracks routed and sealed and accepted.

D. The quantity of grout will be measured as the number of cubic feet of grout placed and accepted.

E. The quantity of spall repair will be measured as the number of cubic feet placed and accepted. Shallow spalls are defined as patches that do not extend below the top mat of reinforcement. Deep spalls are defined as patches that extend below the top mat of reinforcement.

F. The quantity of removed and repaired existing Portland Cement Concrete will be measured as the number of cubic yards of concrete removed and repaired as specified in the Contract Documents and to the satisfaction of the Engineer. Rehabilitation of Portland Cement Concrete masonry is defined as patches that exceed the 0.5 cubic yard threshold in a single area.

G. The quantity of concrete deck repair will be measured as the actual number of square feet of repairs made at the various depths, complete in place and accepted.

H. The quantity of drilling holes and installing dowels will be measured as the actual number of each hole drilled, grouted, and accepted.

628.05 Basis of Payment.

A. The Engineer will pay for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
628001	REPAIR OF CONCRETE STRUCTURES BY EPOXY INJECTION	LF
628010	CRACK SEALING BRIDGE DECKS, APPROACH SLABS, SIDEWALKS, ETC	SF
628011	CRACK SEALING BRIDGE DECKS, APPROACH SLABS, SIDEWALKS, ETC	LF

ITEM	DESCRIPTION	UNIT
628020	ROUT AND SEAL CRACKS	LF
628030	REPAIR OF EXISTING GROUT	CF
628040	SHALLOW SPALL REPAIR	CF
628041	DEEP SPALL REPAIR	CF
628042	REHABILITATION OF PCC MASONRY	CY
628050	DECK REPAIR, 1/2" TO 1" DEPTH	SF
628051	DECK REPAIR 1" TO 3" DEPTH	SF
628052	DECK REPAIR, 3” TO < FULL DEPTH	SF
628053	DECK REPAIR, FULL DEPTH	SF
628070	DRILLING HOLES AND INSTALLING DOWELS	EACH

B. Price and payment for epoxy injection constitutes full compensation for furnishing all Materials, surface preparation, application, cleaning the areas of spills and other contaminates, abrading the concrete surface areas, and for all tools, Equipment, labor, and all incidentals required to complete the Work. Material wasted by the Contractor shall not be measured or paid.

C. Price and payment for deck, approach slab or sidewalk crack sealing constitutes full compensation for furnishing all Materials, surface preparations, application of the crack sealing material and sand, disposal of discarded materials, for all labor, tools, Equipment, and all necessary incidentals to complete the Work.

D. Price and payment for routing and sealing constitutes full compensation for furnishing and placing all Materials, routing of crack, removal of surplus Material, and all labor, Equipment, tools, and incidentals required to complete the Work.

E. Price and payment for repair of existing grout constitutes full compensation for furnishing and placing all Materials including grout, removal and disposal of deteriorated grout, placement and removal of forms, surface preparation, all other Work as described herein and in the Contract Documents, and for all labor, tools, Equipment, and incidentals required to complete the Work.

F. Price and payment for spall repair and rehabilitation of Portland Cement Concrete masonry constitutes full compensation for furnishing and placing all Materials including concrete, abrasive grit-blast cleaning of reinforcement bars, splicing and/or replacement of existing reinforcement bars, removal and disposal of deteriorated concrete, placement and removal of forms, surface preparation, for submission of Working Drawings, all other Work as described herein and in the Contract Documents, and for all labor, tools, Equipment, and incidentals required to complete the Work.

G. Price and payment for concrete deck repair constitutes full compensation for removal and disposal of existing materials including damaged reinforcing bars; splicing and/or replacement of existing reinforcement bars; for furnishing, installing and removing temporary protective Structures when needed; for cleaning bar reinforcement; for furnishing and placing concrete and epoxy grout; for preparing the concrete for patching; and for all labor, Equipment, tools, and incidentals required to complete the Work.

H. Price and payment for drilling holes and installing dowels constitutes full compensation for furnishing and placing all Materials, and for all labor, Equipment, tools, and all incidentals required to complete the Work. Dowels and/or anchor bolts will be measured and paid for under separate Items.

DIVISION 700 MISCELLANEOUS CONSTRUCTION

SECTION 701 PORTLAND CEMENT CONCRETE CURB, INTEGRAL PORTLAND CEMENT CONCRETE CURB, PORTLAND CEMENT CONCRETE MONOLITHIC MEDIAN AND CURB OPENINGS

701.01 Description. Construct Portland Cement Concrete Curb, Integral Portland Cement Concrete Curb, Portland Cement Concrete Median and Curb Openings in accordance with Contract Documents or as directed by Engineer.

701.02 Materials. Provide Materials as specified below:

Graded Aggregate Base Course	Section 1005
Portland Cement Concrete, Class B	Section 1022
Curing Compound	Section 1022
1/2 Inch Preformed Expansion Joint Material	Section 1042
Bituminous Joint Sealant	Section 1042

701.03 Construction. Provide an American Concrete Institute (ACI) or National Ready Mix Concrete Association (NRMCA) certified concrete flatwork technician to supervise all finishing. Provide proof of the flatwork certification to the Engineer prior to concrete placement.

A. Preparation of Foundation.
   1. Excavate to width, depths and grades shown on Plans;
      a. When necessary, remove unsuitable material and replace with approved Material
      b. Compact Material
      c. Excavate 6 inches below the bottom of curb and backfill with GABC where rock is encountered
   2. Place GABC to thickness shown on Plans

B. Slip-Forming.
   1. Use molds of required height, width and shape;

C. Fixed Forms.
   1. Clean wood or metal, extending the full depth of the concrete
   2. Use composite material for radius Work;
      a. Straight and warp free, deflection no greater than 1/8 inch in 10 feet.
      b. Rigid enough to resist the pressure of plastic concrete

D. Removal and replacement of Curb;
   1. Saw cut, 18 inches minimum from the proposed face of curb to allow enough room to achieve compaction and remove curb as shown on Plans or as directed by Engineer
   2. Construct new curb in accordance with this specification
   3. Patch roadway in accordance with Section 402

E. Placing Concrete.
   1. Limitations on placing concrete during hot or cold weather as specified in Section 501.03.6.
   2. Verify string line is true
   3. Wet GABC prior to placement of Portland Cement Concrete;

4. Spray forms with an approved form release agent;
5. Place concrete;
6. Transition the ends of all curbs, approach and exit ends of median island and curb and triangular channelization island curb in accordance with the Standard Construction Details
7. Place polyurethane-bonded recycled rubber (Type IV) expansion joints full depth of curb;
    a. at 160 foot intervals;
    b. the beginning and end of radii;
    c. both sides of all Structures or obstructions (when butted up against rigid structures or pavement)

E. Finishing.
1. Perform to a depth of 2 inches below the exposed surface elevations;
2. Use a wood or magnesium float to rub surface smooth;
3. Check the flow line of the gutter to ensure positive drainage
    a. Match vertical alignment with adjacent surfaces such as curbs and drainage inlets.
    b. Correct deviations in the flow line greater than 1/8 inch in 10 feet.
    c. Correct irregularities in grade or alignment of the front and back edges of the curb greater than ¼ inch in 10 feet.
4. Round front and back edges in accordance with the Standard Construction Details;
5. Brush longitudinally along the surface

F. Curing.

1. Cure with Materials meeting Section 1022.01.5.
    a. Cure any additional surfaces exposed by removal of forms under the same requirements.
    b. No vehicular or pedestrian traffic during the five (5) Day cure period.
    c. Open to traffic after five days, unless compressive strengths of cylinders taken by the Department indicate that the strength of the concrete exceeds 2000 pounds per square inch.

G. Joints.

1. Construct contraction joint by tool or saw cut at 10 foot intervals when concrete is sufficiently set;
    a. When curb is constructed adjacent to concrete pavement, align joints with joints in the pavement.
    b. When sidewalk is behind the curb, align all joints in the curb to coincide with joints in the sidewalk.
    c. When curb is placed adjacent to Portland Cement Concrete pavement the curb or pavement, form or tool to allow sealing as shown in the Standard Construction Details C-1 and P-2.

H. Removal of Forms and backfilling

1. Remove forms and backfill when concrete has hardened sufficiently;
2. Repair all defects
3. Remove and replace entire 10 foot finished section of cracked or damaged curb at the direction of the Engineer, at no cost to the Department.

701.04 Method of Measurement. The Engineer will measure Portland Cement Concrete Curb and Integral Portland Cement Concrete Curb as the number of linear feet measured along the linear face of acceptably installed and completed

curb as specified. Any curb showing cracks shall be replaced in sections that have a minimum length of 10 feet, at no cost to the Department.

Item 701026 - Portland Cement Concrete Monolithic Median will be measured as the number of linear feet measured along the centerline of the median.

Curb openings will be measured as the number of curb openings installed.

701.05 Basis of Payment. Price and payment shall constitute full compensation for excavation within the template of the Item(s), supplying and placing GABC, compaction, forms and forming, supplying, placing, finishing and curing Portland cement concrete, expansion, sealing and saw cutting, backfill and backfilling, removal of surplus Materials, removal and replacement of cracked and/or damaged curb and for all labor, equipment, tools and incidentals required to complete the Work.

Excavation and embankment outside the template of the Item(s) shall be paid under Section 202.

Rock removal shall be paid under Section 202.

Undercut excavation shall be paid under Section 202.

For removal and replacement of curb; P.C.C. removal is paid under Section 211, saw cutting is paid under Section 762 and Bituminous Pavement Patching is paid under Section 402 in addition to the curb Item.

Note: Curb and sidewalk components are not to be placed monolithically unless otherwise directed by the Plans or approved by the Engineer.

Any additional Material used to meet grades due to over excavation is provided at no additional cost to the Department.

ITEM	DESCRIPTION	UNIT
701010	P.C.C. CURB, TYPE 1-2	L.F.
701011	P.C.C. CURB, TYPE 1-4	L.F.
701012	P.C.C. CURB, TYPE 1-6	L.F.
701013	P.C.C. CURB, TYPE 1-8	L.F.
701014	P.C.C. CURB, TYPE 2	L.F.
701015	I.P.C.C. CURB AND GUTTER, TYPE 1-2	L.F.
701016	I.P.C.C. CURB AND GUTTER, TYPE 1-4	L.F.
701017	I.P.C.C. CURB AND GUTTER, TYPE 1-6	L.F.
701018	I.P.C.C. CURB AND GUTTER, TYPE 1-8	L.F.
701019	I.P.C.C. CURB AND GUTTER, TYPE 2	L.F.
701020	I.P.C.C. CURB AND GUTTER, TYPE 3-2	L.F.
701021	I.P.C.C. CURB AND GUTTER, TYPE 3-4	L.F.
701022	I.P.C.C. CURB AND GUTTER, TYPE 3-6	L.F.
701023	I.P.C.C. CURB AND GUTTER, TYPE 3-8	L.F.
701025	P.C.C. CURB TYPE 2 MODIFIED	L.F.
701026	P.C.C. MONOLITHIC MEDIAN	L.F.
701027	P.C.C. CURB TYPE 1-2 MODIFIED	L.F.
701031	CURB OPENING, 2’ OPENING	EACH
701032	CURB OPENING, 4’ OPENING	EACH

SECTION 702 – TRIANGULAR CHANNELIZING ISLANDS

702.01 Description.

Furnish all Materials to construct Triangular Channelizing Island(s) on a prepared foundation as shown in the Contract Documents and/or as directed by the Engineer.

702.02 Materials.

Submit all proposed sources of Materials to Materials and Research Section in accordance with Section 106.01. Provide Materials as specified in:

Graded Aggregate Base Course	Section 1005
Bituminous Pavement	Section 1014
Bituminous Patching	Section 402
Portland Cement Concrete, Class B	Section 1022
Expansion Joint Material	Section 1042
Curing Compound	Section 1022
Delineator	Section 824

702.03 Construction. Provide an American Concrete Institute (ACI) or National Ready Mix Concrete Association (NRMCA) certified concrete flatwork technician to supervise all finishing. Provide proof of the flatwork certification to the Engineer prior to concrete placement.

A. Construction of Triangular Channelizing Island(s)

1. Saw cut existing bituminous concrete pavement or P.C.C. pavement, if applicable;
    a. For bituminous concrete pavements, saw cut 18 inches minimum from the proposed face of curb of the island to allow enough room to achieve compaction for bituminous patching;
    b. For P.C.C. pavement, saw cut at the proposed face of curb.
2. Remove bituminous concrete pavement or P.C.C. pavement and dispose of in accordance with Subsection 106.10 and/or permits, if applicable;
3. Prepare the foundation for the curb in accordance with Section 701.03;
4. Place Graded Aggregate Base Course (GABC) for curb installation at the location and depths shown on the Plans in accordance with Section 301;
5. Layout and pour P.C.C. Curb Type 2 in accordance with Section 701 unless otherwise specified on the Plans or directed by the Engineer;
    a. Finish curb in accordance with Section 701.03
    b. Cure curb in accordance with Section 701.03;
    c. Backfill curb in accordance with Section 701.03 after removal of forms or upon completion of slip-form operation;
6. Prepare the foundation for the sidewalk in accordance with Section 705.03;
7. Place concrete for sidewalk at depth(s) shown on Plans in accordance with Section 705;
    a. Install 4 inch PVC sleeve for signs at locations shown on Plans;
8. Construct Curb Ramps, if applicable, in accordance with the requirements of the Standard Construction Details, any modifications on the Plans and to all the applicable requirements of Section(s) 302 and 705 of the Standard Specifications.

9. Furnish and install Sidewalk Surface Detectable Warning System, if applicable, in accordance with the requirements of the Standard Construction Details and to all the applicable requirements of Section 705.

10. Perform bituminous patching in accordance with Section 402 and/or P.C.C. patching in accordance with Section 503, if applicable, as shown on Plans or otherwise match existing pavement structure;

11. Furnish and install Delineator(s) on the leading ends/corners of the island(s).

702.04 Method of Measurement.

The quantity of Triangular Channelizing Island(s) will be measured as the number of square feet, from face of curb to face of curb, of Triangular Channelizing Island(s) installed and accepted.

Sidewalk Surface Detectable Warning System will be measured and paid for under Item No. 705007.

702.05 Basis of Payment.

The quantity of Triangular Channelizing Island(s) will be paid for at the Contract Unit Price per square foot. Price and payment constitutes full compensation for saw cutting bituminous pavement, saw cutting concrete full depth, removal and disposal of existing Materials, foundation preparation, furnishing and placing all Materials including GABC, concrete for curb and sidewalk, expansion joint Material, construction of curb ramps within the limits of the island, bituminous and/or P.C.C. pavement patching, furnishing and installing delineator(s) and for all labor, tools and incidentals necessary to complete the Work.

No additional payment will be made under other Contract Items for Work necessary to construct the island except Item No. 705007 - Sidewalk Surface Detectable Warning System.

Note: The curb and sidewalk components are not to be placed monolithically unless otherwise directed by the Plans or the Engineer.

ITEM	DESCRIPTION	UNIT
702000	TRIANGULAR CHANNELIZING ISLANDS	SF

SECTION 705 - PORTLAND CEMENT CONCRETE SIDEWALK, CURB RAMPS, AND SIDEWALK SURFACE DETECTABLE WARNING SYSTEM

705.01 Description.

Construct Portland Cement Concrete sidewalk and curb ramps, install sidewalk surface detectable warning system in accordance with the Contract Documents and as directed by the Engineer.

705.02 Materials. Submit all Materials to Materials and Research Section for approval in accordance with Section 106.01. Provide Materials as specified in the following:

Graded Aggregate Base Course, Type B	Section 1005
Portland Cement Concrete, Class B	Section 1022
1/2 Inch Preformed Expansion Joint Material	Section 1042
Joint / Crack Sealant Material	Section 1042
Curing Compound	Section 1022

705.03 Construction. Provide an American Concrete Institute (ACI) or National Ready Mix Concrete Association (NRMCA) certified concrete flatwork technician to supervise all finishing. Provide proof of the flatwork certification to the Engineer prior to concrete placement.

705.03.1 Preparation of Foundation.

A. Excavate to width, depths and grades shown on Plans;

   1. When necessary remove unsuitable material and replace with approved Material
   2. Compact Material

B. Place GABC to thickness shown on Plans

705.03.2 Slip-Forming. Use molds of required height, width and shape. Place concrete in accordance with Section 705.03.3 below with the exception that the expansion joints are permitted to be placed at 100 foot intervals when slip-forming.

705.03.3 Fixed Forms.

A. Clean, wood or metal, extending the full depth of the concrete

B. Use composite material for radii Work;

   1. Straight and warp free, deflection no greater than 1/8 inch in 10 feet
   2. Rigid enough to resist the pressure of plastic concrete.

C. Placing Concrete

   1. Limitations on placing concrete during hot or cold weather as specified in Section 501.03.6;
   2. Wet GABC prior to placement of Portland Cement Concrete;
   3. Spray forms with an approved form release agent;
   4. Place concrete;
   5. Place polyurethane-bonded recycled rubber (Type IV) expansion joints full depth of sidewalk;
      a. at 20 foot intervals
      b. the beginning and end of radii
      c. both sides of all Structures or obstructions.
   6. Finishing;

a. Use a wood or magnesium float to rub surface smooth;

b. Match vertical alignment with adjacent surfaces;

c. Correct surface deviations greater than 1/4 inch in 10 feet;

d. Tool exposed edges in accordance with the Standard Construction Details;

e. Brush perpendicular along the surface

705.03.4 Joints

A. Construct contraction joint by tool or saw cut at 10 foot intervals when concrete is sufficiently set;

1. When sidewalk is behind the curb, align all joints in the curb to coincide with joints in the sidewalk.

B. Cure sidewalk in accordance with Section 701.03.

705.03.5 Removal of Forms and backfilling.

A. Remove forms and backfill when concrete has hardened sufficiently

B. Repair all defects

C. Remove and replace entire 10 foot long finished section of cracked or damaged sidewalk as directed by Engineer.

705.03.6 Curb Ramps

A. Construct Curb ramps in accordance with the Contract Documents.

705.03.7 Surface Detectable Warning System

A. Submit samples of the proposed system to the Engineer for approval prior to the start of Work.

B. Submit mortar mix formula for concrete sidewalk applications to the Engineer for approval prior to the start of Work.

C. Submit certification that the surface of the system is slip resistant using one of the following standard methods:

1. ASTM C1028 B Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method

2. ASTM D2047 B Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine

3. ASTM E303 B Measuring Surface Frictional Properties Using the British Pendulum Tester

4. VOSI V41.21-98 B Universal Specification / Test Method for Slip Resistant Walkways, in the Field and Laboratory, as measured by a Drag Type Friction Tester (Voices of Safety International (VOSI): www.voicesofsafety.com)

D. Utilize the dome pattern shown in the Standard Construction Details.

E. Use one of the following material systems:

1. Precast concrete or fired clay brick paver units: manufactured with the truncated dome pattern, set on the concrete sidewalk surface.

a. Use mortar for adhesion to the sidewalk surface and for joint filling.

2. Cast iron plates: manufactured with the truncated dome pattern, set on the concrete sidewalk surface.

a. Anchor the plates to the sidewalk surface according to manufacturer's recommendations.

3. Stamping systems, applied membranes and ceramic tiles are not acceptable for new Work.

4. The color of the final surface of the system must conform to the table below or as specified on the Plans.

Sidewalk Surface	Detectable Warning System Color
Brick	white, federal yellow, pale yellow
Bituminous	white, light gray, federal yellow, pale yellow
Concrete	brown, dark gray, red, brick red, black

The Engineer will determine the color, with a light to dark contrast, for sidewalk surfaces not listed above if not already specified on the Plans.

F. *P.C.C. sidewalk*: Use precast concrete or fired brick paver units.

1. Construct the base material of the sidewalk section receiving the detectable warning surface at a lower elevation to allow the thickness of the concrete under the detectable warning system to be the same as the sidewalk (minimum of 6 inches).
2. Install paver units to achieve a flush surface with the surrounding ramp/sidewalk surfaces.
3. *Mortar*:
   a. Mix Portland cement mortar in the following proportion: one part Portland cement to three parts fine aggregate, add hydrated lime not to exceed 10 percent of the cement by weight.
   b. Dry mix the fine aggregate, Portland cement, and lime until the mixture assumes a uniform color.
   c. Add water as the mixing continues until the mortar attains a consistency that can be easily handled and spread with a trowel.
   d. Mortar that is not used within 30 minutes after water has been added cannot be used.
   e. Retempering of mortar will not be permitted.
4. Place the mortar to form a firm bond.
5. Set paver units in a bed of mortar and mortar the joints.
   a. Maintain 1/4 inch wide joints, no larger than 3/8 inch. Plastic spacers may be used.
   b. Keep joints uniform and straight in all both directions.
6. Maintain clean surfaces and joints prior to applying grout.
7. Bevel edges of the system with grade changes in between 0.25 and 0.50 inch with a slope no steeper than 2 to 1.
8. Grade changes up to 0.25 inch may be vertical.

G. *Brick sidewalks:* Use precast concrete panels or fired brick paver units.

1. Place units on the same base material and lift thickness as used under the brick sidewalk.
2. Place units to achieve a flush surface with the surrounding ramp/sidewalk surfaces.

705.04 Method of Measurement.

705.04.1 *Sidewalk.* The quantity of sidewalk will be the measured square feet of sidewalk acceptably completed.

705.04.2 *Sidewalk Surface Detectable Warning System.* The quantity of sidewalk surface detectable warning system will be measured as the actual number of square feet acceptably completed. Sidewalk will be measured and paid for separately.

705.04.3 *Curb Ramp(s).* The quantity of curb ramps will be the measured square feet surface area of curb ramp acceptably completed.

A. The area of curb ramps will be established by the measurement of the curb, sidewalk and taper areas shown

in the Standard Details.

B. Curb ramp(s) constructed in conjunction with the new P.C.C. sidewalk will be measured and paid for under P.C.C. sidewalk.

No measurement for payment will be made on vertical surfaces of curb or sidewalk.

Sidewalk or curb removed and/or replaced beyond the minimum limits required to achieve the slopes shown in the Standard Construction Details as measured from the nearest edge of the landing area will be paid under the appropriate Items for concrete removal, sidewalk, curb, and hot mix patching unless otherwise noted on the Plans. The limit of removal and replacement will be the minimum area required to achieve the allowable slopes as shown in the Standard Construction Details

705.05 Basis of Payment.

705.05.1 *Sidewalk.* The quantity of sidewalk shall be paid for at the Contract Unit Price per square foot of sidewalk acceptably completed. Price and payment constitutes full compensation for excavation within the template of this Item, forms and forming, GABC, concrete, expansion joint material, backfill and backfilling, removal of surplus Materials, removal and replacement of cracked and/or damaged sidewalk in complete 5 foot long sections, and for all labor, Equipment, tools and incidentals required to complete the Work.

705.05.2 *Sidewalk Surface Detectable Warning System.* The quantity of sidewalk surface detectable warning system shall be paid for at the Contract Unit Price per square foot. Price and payment constitutes full compensation for furnishing all Materials, constructing base, installing sidewalk surface detectable warning system, grouting joints, and for all labor, Equipment, tools and incidentals required to complete the Work.

705.05.3 *Curb Ramps.* The area of curb ramps shall be paid for at the Contract Unit Price per square foot. Price and payment constitutes full compensation for excavation within the template of this Item, grading and compacting, including the curb and pavement areas within the limits of the ramp, furnishing and placing all Materials including graded aggregate base course, curb, concrete, bituminous or concrete for patching along the curb line, expansion material, saw cutting, removal and disposal of the existing curb, gutter, sidewalk and pavement, and for all equipment, labor, tools, and incidentals necessary to complete the Work.

A. Curb ramps constructed along the new P.C.C. sidewalk are paid in accordance with Item 705002 – P.C.C. Sidewalk, 6”

Rock removal shall be paid under Section 202.

Undercut excavation shall be paid under Section 202.

For removal and replacement of sidewalk, P.C.C. removal shall be paid under Section 211 and saw cutting shall be paid under Section 762.

ITEM	DESCRIPTION	UNIT
705001	P.C.C. SIDEWALK, 4”	SF
705002	P.C.C. SIDEWALK, 6”	SF
705005	P.C.C. SIDEWALK, 8”	SF
705007	SIDEWALK SURFACE DETECTABLE WARNING SYSTEM	SF
705008	CURB RAMP, TYPE 1	SF
705009	CURB RAMP, TYPE 2, 3 &/OR 4	SF
705010	CURB RAMP, TYPE 5	SF

SECTION 706 – MONUMENT

706.01 Description.

Furnish all Materials and labor to set P.C.C. Monuments in accordance with Contract Documents and as directed by the Engineer.

706.02 Materials.

Provide monument constructed in accordance with the Contract Documents using Materials specified in:

Portland Cement Concrete – Class B	Section 1022
Bar Reinforcement	Section 1037

706.03 Construction Methods.

A. Exact location to be set by a Delaware Professional Land Surveyor in accordance with the Plans or as directed by the Engineer.

B. Place monuments vertically in excavated holes at depths shown on the Plans or as designated, with two sides approximately parallel with the roadway.

C. Place backfill material in layers and firmly tamp without disturbing the location set by the surveyor so that the monument is stable and secure.

D. Take care not to break or damage monuments when removing and resetting.

E. Replace broken or damaged monuments in kind without added compensation.

706.04 Method of Measurement.

Monuments will be measured as the actual number of monuments set and accepted.

706.05 Basis of Payment.

The quantity of monuments shall be paid for at the Contract Unit Price per each monument installed. Price and payment constitutes full compensation for excavation and backfill, furnishing and setting the monument(s) by a Delaware Professional Land Surveyor, and all incidentals necessary to complete the Item.

Existing monuments damaged will be repaired or replaced and set at no expense to the State as required in Section 107.09.

ITEM	DESCRIPTION	UNIT
706000	MONUMENT	EACH
706001	RELOCATE MONUMENT	EACH

SECTION 707 – RIPRAP

707.01 Description. Prepare the bedding areas, furnish and place dry, pre-mixed, bagged riprap and stone riprap in accordance with the Contract Documents and as directed by the Engineer.

707.02 Materials.

Provide Materials as specified in:

Bagged Riprap	Section 1030
Stone	Section 1006
Geotextile	Section 1060

707.03 Construction Methods.

707.03.1 Pre-Sacked Concrete Riprap. If not installed the same day of delivery, protect the pre-sacked concrete riprap from moisture by a waterproof covering such as polyethylene. Prior to installation, replace bags rejected by the Department containing Material which has begun to hydrate due to prolonged storage, inadequate protection, or other causes at no additional cost to the Department.

Place pre-sacked riprap on slopes for protection in accordance with the Contract Documents. Place so the bagged riprap has 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. Remove and replace any bags ripped or torn with sound, unbroken bags. Thoroughly wet the bagged riprap by hosing, sprinklers, or other approved methods capable of providing sufficient water to saturate the entire installation and initiate the cement hydration process. When multiple courses are specified, thoroughly wet each new course of bagged riprap before the next course is placed. In multi-level construction, ensure all joints are clean, and intimate bag to bag contact is provided to ensure good bonding.

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.

707.03.2 Stone Riprap. Place riprap to the dimensions and at the locations shown on the Plans or as established by the Engineer.

Excavate the area for placement of the stone riprap to the required placement depth in accordance with the Contract Documents.

Properly prepare the placement area to 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.

Install geotextile in accordance with Section 708 and the Contract Documents.

Carefully place the riprap on the geotextile to produce an even distribution of pieces, with a minimum of voids and without tearing the geotextile. Place the riprap to the full-course thickness in a manner which prevents segregation of stone sizes and which prevents displacement of underlying Material. If necessary, rearrange individual stones to ensure a uniform distribution.

707.04 Method of Measurement. The quantity of pre-sacked concrete riprap will be measured as the actual number of cubic yards 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, cubic yards or the actual number of tons of riprap for each class placed and accepted. If stone riprap is measured by the square yard, 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, the weight will be determined as specified in Section 109.01.

707.05 Basis of Payment. The quantity of pre-sacked concrete riprap is paid for at the Contract Unit Price per cubic yard. The quantity of stone riprap is paid for at the Contract Unit Price per square yard, cubic yard or 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 its separate pay Item.

ITEM	DESCRIPTION	UNIT
707001	RIPRAP, R-4	SY
707002	RIPRAP, R-5	SY
707003	RIPRAP, R-6	SY
707004	RIPRAP, R-7	SY
707005	RIPRAP, R-8	SY
707010	RIPRAP, R-4	CY
707011	RIPRAP, R-5	CY
707012	RIPRAP, R-6	CY
707013	RIPRAP, R-7	CY
707014	RIPRAP, R-8	CY
707015	RIPRAP, R-4	TON
707016	RIPRAP, R-5	TON
707017	RIPRAP, R-6	TON
707018	RIPRAP, R-7	TON
707019	RIPRAP, R-8	TON
707020	PRESACKED CONCRETE RIPRAP	CY

SECTION 708 – GEOTEXTILES

708.01 Description. Furnish and place geotextiles in accordance with the Contract Documents and as directed by the Engineer.

708.02 Materials. Provide Materials as specified in:

Geotextile	Section 1060

708.03 Construction. Place the geotextile on a prepared suitable base area in a loose unstretched condition to minimize tearing and shifting. Join the adjacent edges of the fabric with a lock-type or chain-type stitch folded seam or overlap adjacent swaths of fabric a minimum of 12 inches, if permitted. The overlap direction shall be upstream over downstream and upslope over downslope. Anchor the fabric in place using securing pins or other acceptable methods. Cover the fabric as soon as possible so that it is not exposed for more than two weeks.

708.04 Method of Measurement. The quantity of geotextile will be measured as the actual number of square yards 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.

708.05 Basis of Payment. The quantity of geotextile will be paid for at the Contract Unit Price per square yard. 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.

ITEM	DESCRIPTION	UNIT
708001	GEOTEXTILES, STABILIZATION	SY
708002	GEOTEXTILES, SEPARATION	SY
708003	GEOTEXTILES, RIPRAP	SY

SECTION 709 – PERFORATED PIPE UNDERDRAINS

709.01 Description. Construct underdrains from perforated, corrugated metal pipe or perforated, corrugated polyethylene tubing in accordance with the Contract Documents and as directed by the Engineer.

709.02 Materials. Provide Materials as specified in the following:

Perforated, Corrugated Metal Pipe	Section 1031
Perforated, Corrugated Polyethylene Pipe	Section 1031
Stone, Delaware No. 57	Section 1004
Geotextile	Section 1060

709.03 Construction Methods.

Construct underdrain in accordance with the Contract Documents. Place the pipe as directed by the Engineer. Make lateral connections to the pipe with connectors recommended by the manufacturer. Place stone backfill in 6 inch lifts and compacted with a vibratory plate to the satisfaction of the Engineer.

709.04 Method of Measurement.

The quantity of perforated pipe underdrains will be measured from end-to-end in linear feet of pipe completed and accepted.

709.05 Basis of Payment.

The quantity of perforated pipe underdrains will be paid for at the Contract Unit Price per linear foot. 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 202.

ITEM	DESCRIPTION	UNIT
709000	PERFORATED PIPE UNDERDRAINS, 4”	LF
709001	PERFORATED PIPE UNDERDRAINS, 6”	LF
709002	PERFORATED PIPE UNDERDRAINS, 8”	LF
709004	PERFORATED PIPE UNDERDRAINS, 12”	LF
709005	PERFORATED PIPE UNDERDRAINS, 15”	LF
709006	PERFORATED PIPE UNDERDRAINS, 24”	LF

SECTION 710 – WATER SERVICES

710.01 Description.

Furnish, transport, install and test the water main, line, laterals and accessories in accordance with the Contract Documents and as directed by the Engineer. Adjust or relocate existing water services, connections and appurtenances to locations shown in the Contract Documents. Perform the Work in accordance with these Specifications and the requirements of the standards and specifications of the owner of the Utility ("Owner"). In case of conflict between the Contract Documents and the standards and specifications of the Owner, the standards and specifications of the Owner will govern the Work.

710.02 Materials.

Provide Materials as specified in the following:

Pipe	Section 1031
Portland Cement Concrete, Class B	Section 1022
Backfill, Borrow Type C	Section 1001
Stone, Delaware No. 8	Section 1004

710.03 Construction.

Patches for all appurtenances adjusted after the paving operations will require a perimeter reservoir and will be sealed in accordance with Section 504.

710.03.1 Special Requirements.

Coordinate all water service construction activities with the Owner including, but not limited to, requests for system shut downs and inspections. Provide the Owner with reasonable time to respond to requests for information and coordination. Submit (3 weeks prior to beginning the Work), for approval, a plan describing the logical sequence for water service shut-downs and tie-ins.

If necessary, furnish, install, and remove bypass and temporary services pipes to maintain water service to customers during the Work. Furnishing, installing services and other branches, maintaining, providing safety precautions and removal of temporary services is the responsibility of the Contractor. Use only the highest quality service pipe, connections and branches that are able to withstand 150 pounds per square inch pressures and all conditions of use. Ensure that all pipes and fittings are watertight and that care is exercised throughout the installation to avoid pollution of mains, hose services or temporary service pipe.

Place temporary service pipe in the gutters where possible. Provide pipe crossings at driveways with cold patch cover or other methods approved by the Engineer. At street crossings, place temporary pipe in shallow trenches covered with temporary surfacing or other methods approved by the Engineer. Use sanitary precautions that are satisfactory to both the Engineer and the Owner. Chlorinate the interior of temporary service pipe in accordance with the latest AWWA Manual C601-81 "AWWA Standard for Disinfecting Water Mains". Chlorine and bacteria testing will be performed by the Owner's inspector.

The Owner and the Engineer retain the sole right of determining the times that the Work can occur and the sequence of the Work. Do not begin Work until both the Owner and the Engineer grant permission to proceed. Notify the Owner a minimum of forty-eight (48) hours before beginning Work to allow the Owner to arrange inspection. Immediately notify both the Engineer and the Owner of all delays to the scheduled Work.

It is of prime importance that the Contractor, in the performance of the Work, does not disrupt the operation of the existing water facilities in any manner or at any time, without the expressed prior approval of the Owner. Construct, disinfect, maintain and remove, following construction, such temporary water bypasses as may be required during construction to maintain water mains in service. No separate payment will be made for such temporary water bypasses.

The Contractor will be permitted to close down specific water mains and services for a period of time not exceeding

four (4) hours after obtaining approval from the Owner in order to make connections as shown in the Contract Documents. The schedule for making connections will be so arranged that the water users will be out-of-service for a minimum period of time. The Contractor will receive no additional compensation for working during off-peak hours.

Before any shutdown, as specified above, the Contractor must give the utility owner and local 911 Center and Fire Department forty-eight (48) hours notice; and the Contractor must also furnish written notice to all water users in the area, a minimum of forty-eight (48) hours in advance of the closing of any water valves which may interrupt customer water service.

Shutdowns are not permitted if tapping sleeves and valves are specified for making the connections. Any and all emergency repairs required are the responsibility of the Contractor. Upon notification via telecommunication from the Owner, attend to any repairs immediately. In the event the Owner is unable to contact the Contractor or the Contractor fails to make the emergency repairs in a length of time determined by the Owner, the Owner reserves the right to attend to any or all emergency repair work. In such a case, the Contractor is responsible for reimbursements due to the Owner for the costs of the repairs.

Remove and replace or repair all Materials and Work, or parts thereof, which are deemed unsatisfactory as to any or all requirements of the Owner or the Engineer or as specified herein, at no expense to the State or the Owner.

Guarantee all workmanship, Materials and Work performed is in strict accordance with the Contract Documents, for a period of two years from and after the date of Completion and Acceptance of the Work. Repair, correct or replace as required, promptly and without charge, all Work, Equipment and Material, or parts thereof, which fail to meet the above guarantee, or which in any way fail to comply with or fail to be in strict accordance with the terms, provisions and requirements of the Contract during such two-year period.

710.03.2 Excavation.

Perform excavation and trenching in accordance with Section 207, except as amended by this Section. Excavate pipe trenches so that the bottoms of the trenches are flat and will provide bearing for the full length of pipes placed in them. Excavate trenches so that the elevations of water pipes and fittings placed in the trenches match the elevations provided in the Contract Documents. Excavate trenches for water service connections to the minimum standard depth required by the Owner’s specifications or to such depth as required to connect to existing mains or service pipes.

The Engineer and the Owner will have the right to limit the amount of trench opened in advance of pipe to be placed, and the amount of pipe placed in advance of backfilling. Upon demand by either the Owner or the Engineer, immediately refill open trenches as directed. Claims for extra compensation due to immediate demands for backfilling, even if such backfilling compels the Contractor to temporarily stop other Work, will not be considered.

If the Contractor stops Work on any trench or excavation for any reason and the excavation is left open for an unreasonable length of time (in the opinion of the Engineer) in advance of construction, refill such trench or excavation at the Contractor’s expense at no extra cost to the Owner or the State. Do not re-excavate the trench until the Engineer determines that the Contractor is ready and able to progress the Work.

Where rock is encountered within the proposed limits of a water main trench, remove the rock in accordance with Section 202.03.6, except as modified herein, and excavate an additional six inches below grade. After the excavation is complete, place a bed of Borrow Type C six inches in depth at the bottom of the trench. Level off and thoroughly tamp the bed. If blasting is required to remove the rock, perform blasting operations in accordance with Section 107.08.

710.03.3 Installation.

Adjust, relocate, repair or install new water services and appurtenances of the sizes and to the lines in accordance with the Contract Documents and the requirements of the Owner's Specifications. Thoroughly clean all pipes, fittings, valves, hydrants and appurtenances before placement and keep clean until acceptance of the Work. No Work may be performed except under the supervision of the Owner's inspector.

At the close of the Work each Day, tightly close the end of each pipe to prevent dirt, foreign substances or small animals from entering the pipe until the Work is resumed.

Carefully handle and lower pipes and fittings into the trench. Take special care to ensure that all pipes are well bedded on solid foundations. Repair any defects due to settlement at the Contractor's expense.

Where the manufacturer's recommended pipe joint deflection is exceeded, place mechanical joint bends to realign the pipe to the satisfaction of the Owner and the Engineer at the Contractor's expense.

Use thrust blocks made of Portland Cement Concrete, Class B to secure all fittings and all bends equal to or greater than 11-1/4 degrees. Use thrust blocks of adequate size and weight to resist the force of water pressure and water hammer. Thrust blocks must be used unless the Owner's specifications or the Contract Documents permit a different method to secure the fittings. All methods used to secure fittings, including, but not limited to, thrust blocks, couplings and service saddles are incidental to the fittings and no separate payment will be made for this Work.

Do not place pipe on a frozen foundation or if frost is likely to penetrate the bottom of an excavation. Keep all excavations free from water or other liquids during the progress of the Work. Excavate and backfill trenches per the applicable requirements of Section 207. Remove all excess Material in accordance with Section 106.08.

710.03.4 Pressure Testing.

Conduct pressure tests per the specifications of the Owner. Upon completion of the relocated/new water services, adequately plug the ends of the line and charge the line to 150 pounds per square inch. The maximum allowable leakage is in accordance with AWWA C605. Install any taps required at high points on the line to expel trapped air prior to testing. Following the tests, tightly plug all taps with suitable threaded brass plugs.

Water for testing purposes will be furnished by the Owner. Furnish and install adequate pumping and gauging Equipment to develop the required hydrostatic pressure and to measure the pressure and amount of water lost by leakage. Perform pressure test(s) with a duration not less than two (2) hours. Repair all visible leaks regardless of total leakage shown by test.

If inspections or tests show defects, including visible leaks, replace such defective Work or Material at the expense of the Contractor and repeat the inspection and tests. Make all repairs using new Material. Failure to meet the requirements of the tests specified above will be sufficient cause to reject the Work until the defects are satisfactorily repaired. All expenses and costs incurred in carrying out the specified tests are borne by the Contractor, at no extra cost to the Owner or to the State, and included in the Contract Unit Price per linear foot bid for the various sizes of installing water services.

710.03.5 Sterilization of Main, Line, Laterals and Accessories.

Prior to the final connection of the newly installed pipe into the existing water main, and with the plugs used in the pressure test still in place on the installed pipe, sterilize the entire installed system using one of the procedures as specified in AWWA Standard C601-81 and as required by the Owner.

Provide an adequate blowoff for use in flushing of the main. Before the water is turned on for use by the consumer from the relocated mains, the Owner will conduct bacteriological tests on water samples taken from the blowoff. All expenses incurred in the performance of these tests by the Owner are borne by the Contractor. Upon final sanitary approval by the Owner, return water service for use by the consumer.

Before the final connection is made, thoroughly clean all surfaces of the relocated line, including all gaskets and glands, and the existing water main that are to become part of the closing joint with a 5 percent solution of Sodium Hypochlorite. Exercise extreme care in order to prevent the entrance of any contaminants into the main.

All expenses and cost incurred in carrying out the specified sterilization work is borne by the Contractor at no extra cost to the Owner or the State and is included in the Contract Unit Price per linear foot bid for the Item for the various sizes.

Abandoning and/or Removing Existing Water Mains – Remove and dispose of all existing water mains which are to be abandoned that are located within the limits of excavation. Plug adjacent pipe openings as required in accordance with the Section 202.03.2.

Final Location Drawings - Within thirty (30) Days after completion of required Work, submit an accurate print or prints showing the horizontal and vertical location of mains, bends and other appurtenances to the Engineer and the

Owner.

710.04 Method of Measurement.

The quantity of the respective water service and accessory Items will be measured either by linear foot or each, as installed, adjusted, or relocated and accepted.

710.05 Basis of Payment.

Price and payment for water service Items includes furnishing, transporting and installing the Materials; adjusting, relocating or repairing the services, testing of the water main system; for repairing leaks and defects, including defects to settlement, connecting to existing water main systems and services; maintaining service as required; excavating; disposing of excess excavated Material; backfilling; furnishing Material for backfilling; furnishing and installing concrete thrust blocks, joint restraints, pipe bedding, sheeting and shoring, temporary support of existing Utilities, dewatering; abandoning existing pipes, cutting and capping new or existing lines and for all labor, Equipment, tools and necessary incidentals to achieve and accept an operational water main system.

The Department reserves the right to delete from the Contract one or more Items listed and the right to add or subtract from the quantity of each Item. There will be no extra compensation or increase in Unit Prices for each Item if such additions and/or deletions are made to the quantities.

ITEM	DESCRIPTION	UNIT
710000	DUCTILE IRON PIPE CLASS 51, CEMENT LINED, 16"	LF
710001	ADJUST WATER SERVICES	EACH
710002	ADJUST WATER VALVE BOXES	EACH
710003	ADJUST FIRE HYDRANTS	EACH
710005	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 2"	LF
710006	DUCTILE IRON PIPE, CLASS 52, CEMENT LINED, 3"	LF
710007	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 4"	LF
710008	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 6"	LF
710009	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 8"	LF
710010	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 10"	LF
710011	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 12"	LF
710012	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 16"	LF
710013	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 18"	LF
710014	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 20"	LF
710015	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 24"	LF
710016	DUCTILE IRON PIPE CLASS 52, CEMENT LINED, 36"	LF
710020	DUCTILE IRON PIPE CLASS 55, CEMENT LINED, 8"	LF
710025	DUCTILE IRON PIPE CLASS 56, CEMENT LINED, 12"	LF
710030	PVC WATER MAIN, 8"	LF
710031	PVC WATER MAIN, 10"	LF
710032	PVC WATER MAIN, 12"	LF
710033	PVC WATER MAIN, CLASS 200, 6"	LF
710034	PVC WATER MAIN, CLASS 200, 8"	LF
710035	PVC WATER MAIN, CLASS 200, 12"	LF
710036	D.I.P. CLASS 52 CEMENT LINED 8" BOLTLESS RESTRAINED JOINTS	LF
710037	H.D.P.E. PIPE, 14"	LF
710038	FURNISHING AND INSTALLING WATER MAINS AND FITTINGS	LF

710039	FURNISHING AND INSTALLING HDPE WATER MAIN VIA DIRECTIONAL DRILL	LF
710040	FURNISHING AND INSTALLING GATE VALVE AND VALVE BOXES	EACH
710050	4" DI JOINT RESTRAINT FOR PVC PUSH-ON JOINT	EACH
710051	6" JOINT RESTRAINT FOR DI MJ JOINT	EACH
710052	BENDS 11 1/4 DEGREES, 6"	EACH
710053	BENDS 11 1/4 DEGREES, 10"	EACH
710054	BENDS 11 1/4 DEGREES, 12"	EACH
710055	BENDS 11 1/4 DEGREES, 16"	EACH
710056	BENDS 11 1/4 DEGREES, 18"	EACH
710057	BENDS 22 1/2 DEGREES, 6"	EACH
710058	BENDS 22 1/2 DEGREES, 8"	EACH
710059	BENDS 22 1/2 DEGREES, 10"	EACH
710060	BENDS 22 1/2 DEGREES, 12"	EACH
710061	BENDS 22 1/2 DEGREES, 16"	EACH
710062	BENDS 22 1/2 DEGREES, 24"	EACH
710063	BENDS 45 DEGREES, 2"	EACH
710064	BENDS 45 DEGREES, 4"	EACH
710065	BENDS 45 DEGREES, 6"	EACH
710066	BENDS 45 DEGREES, 8"	EACH
710067	BENDS 45 DEGREES, 10"	EACH
710068	BENDS 45 DEGREES, 12"	EACH
710069	BENDS 45 DEGREES, 14"	EACH
710070	BENDS 45 DEGREES, 16"	EACH
710071	BENDS 45 DEGREES, 20"	EACH
710072	BENDS 45 DEGREES, 24"	EACH
710073	BENDS 67 1/2 DEGREES, 8"	EACH
710074	BENDS 90 DEGREE, 2"	EACH
710075	BENDS 90 DEGREE, 4"	EACH
710076	BENDS 90 DEGREES, 6"	EACH
710077	BENDS 90 DEGREES, 8"	EACH
710078	BENDS 90 DEGREES, 10"	EACH
710079	BENDS 90 DEGREES, 12"	EACH
710080	BENDS 90 DEGREES, 16"	EACH
710100	BUTTERFLY VALVES, 6"	EACH
710101	BUTTERFLY VALVES, 8"	EACH
710102	BUTTERFLY VALVES, 12"	EACH
710103	BUTTERFLY VALVES, 16"	EACH
710104	BUTTERFLY VALVES, 20"	EACH
710105	CROSS 8"X8"	EACH
710106	CROSS 10"X10"	EACH
710107	CROSS 12" X12"	EACH
710108	CROSS 16"X8"	EACH

710109	END CAP, 8"	EACH
710110	END CAP, 20"	EACH
710111	END CAP, 24"	EACH
710112	END PLUG FOR BELL END PIPE, 12"	EACH
710113	END PLUG FOR BELL END PIPE, 16"	EACH
710114	END PLUG FOR BELL END PIPE, 20"	EACH
710115	END PLUG, 6"	EACH
710116	END PLUG, 16"	EACH
710117	GATE VALVES, 2"	EACH
710118	GATE VALVES, 4"	EACH
710119	GATE VALVES, 6"	EACH
710120	GATE VALVES, 8"	EACH
710121	GATE VALVES, 10"	EACH
710122	GATE VALVES, 12"	EACH
710123	GATE VALVES, 16"	EACH
710124	GATE VALVES, 20"	EACH
710125	GATE VALVES, 24"	EACH
710126	INCREASER, 4"X8"	EACH
710127	INCREASER, 8"X10"	EACH
710128	INCREASER, 10"X12"	EACH
710129	INCREASER, 12"X16"	EACH
710130	INSERTING VALVE, 12"	EACH
710131	M.J. 11 1/4 DEGREES BEND, 8"	EACH
710132	M.J. 11 1/4 DEGREES BEND, 10"	EACH
710133	M.J. 11 1/4 DEGREES BEND, 12"	EACH
710134	M.J. 11 1/4 DEGREES BEND, 16"	EACH
710135	M.J. 11 1/4 DEGREES BEND, 18"	EACH
710136	M.J. 11 1/4 DEGREES BEND, 20"	EACH
710137	M.J. 11 1/4 DEGREES BEND, 24"	EACH
710138	M.J. 22 1/2 DEGREES BEND, 4"	EACH
710139	M.J. 22 1/2 DEGREES BEND, 6"	EACH
710140	M.J. 22 1/2 DEGREES BEND, 8"	EACH
710141	M.J. 22 1/2 DEGREES BEND, 10"	EACH
710142	M.J. 22 1/2 DEGREES BEND, 12"	EACH
710143	M.J. 22 1/2 DEGREES BEND, 16"	EACH
710144	M.J. 22 1/2 DEGREES BEND 18"	EACH
710145	M.J. 22 1/2 DEGREES BEND, 20"	EACH
710146	M.J. 45 DEGREES BEND, 3"	EACH
710147	M.J. 45 DEGREES BEND, 4"	EACH
710148	M.J. 45 DEGREES BEND, 6"	EACH
710149	M.J. 45 DEGREES BEND, 8"	EACH
710150	M.J. 45 DEGREES BEND, 10"	EACH

710151	M.J. 45 DEGREES BEND, 12"	EACH
710152	M.J. 45 DEGREES BEND, 16"	EACH
710153	M.J. 45 DEGREES BEND, 18"	EACH
710154	M.J. 45 DEGREES BEND, 20"	EACH
710155	M.J. 45 DEGREES BEND, 24"	EACH
710156	M.J. 90 DEGREES BEND, 3"	EACH
710157	M.J. 90 DEGREES BEND, 4"	EACH
710158	M.J. 90 DEGREES BEND, 8"	EACH
710159	M.J. 90 DEGREES BEND, 10"	EACH
710160	M.J. 90 DEGREES BEND, 12"	EACH
710161	M.J. CUTTING-IN SLEEVE, 4"	EACH
710162	M.J. CUTTING-IN SLEEVE, 10"	EACH
710163	M.J. GATE VALVE, 3" WITH C.I. BOX AND COVER	EACH
710164	M.J. GATE VALVE, 4" WITH C.I. BOX AND COVER	EACH
710165	M.J. GATE VALVE, 6" WITH C.I. BOX AND COVER	EACH
710166	M.J. GATE VALVE, 8"	EACH
710167	M.J. GATE VALVE, 8" WITH C.I. BOX AND COVER	EACH
710168	M.J. GATE VALVE, 10"	EACH
710169	M.J. GATE VALVE, 10" WITH C.I. BOX AND COVER	EACH
710170	M.J. GATE VALVE, 12" WITH C.I. BOX AND COVER	EACH
710171	M.J. INCREASER, 20"X 20"	EACH
710172	M.J. INCREASER, 20"X 24"	EACH
710173	M.J. PIPE CAP, 2"	EACH
710174	M.J. PIPE CAP, 4"	EACH
710175	M.J. PIPE CAP, 6"	EACH
710176	M.J. PIPE CAP, 8"	EACH
710177	M.J. PIPE CAP, 10"	EACH
710178	M.J. PIPE CAP, 12"	EACH
710179	M.J. PIPE CAP, 16"	EACH
710180	M.J. PIPE CAP, 16"	EACH
710181	M.J. PIPE CAP, 20"	EACH
710182	M.J. PIPE CAP, 36"	EACH
710183	M.J. PLUG, 4"	EACH
710184	M.J. PLUG, 8"	EACH
710185	M.J. PLUG, 12"	EACH
710186	M.J. REDUCER, 6"X4"	EACH
710187	M.J. REDUCER, 8" X3"	EACH
710188	M.J. REDUCER, 8"X4"	EACH
710189	M.J. REDUCER, 8"X6"	EACH
710190	M.J. REDUCER, 10" X8"	EACH
710191	M.J. REDUCER, 12"X10"	EACH
710192	M.J. REDUCER, 12"X6"	EACH

710193	M.J. REDUCER, 12"X8"	EACH
710194	M.J. REDUCER, 14"X12"	EACH
710195	M.J. REDUCER, 16"X10"	EACH
710196	M.J. REDUCER, 16"X12"	EACH
710197	M.J. REDUCER, 20"X12"	EACH
710198	M.J. REDUCER, 20"X16"	EACH
710199	M.J. REDUCER, 24"X6"	EACH
710200	M.J. REDUCER, 24"X12"	EACH
710201	M.J. REDUCER, 24"X16"	EACH
710202	M.J. REDUCER, 24"X20"	EACH
710203	M.J. REDUCER, 24"X24"	EACH
710204	M.J. SLEEVE, 12"	EACH
710205	M.J. SLEEVE, 16"	EACH
710206	M.J. SOLID SLEEVE, 10"	EACH
710207	M.J. TAP PLUG, 2"	EACH
710208	M.J. TEE, 8"X3"	EACH
710209	M.J. TEE, 8"X4"	EACH
710210	M.J. TEE, 8"X8"X8"	EACH
710211	M.J. TEE, 12"X12"X10"	EACH
710212	M.J. TEE, 12"X12"X8"	EACH
710213	M.J. TEE, 12X12"X12"	EACH
710214	M.J. TEE, 16"X16"X10"	EACH
710215	M.J. TEE, 16"X16"X12"	EACH
710216	M.J. TEE, 16"X16"X16"	EACH
710217	M.J. TEE, 16"X16"X8"	EACH
710218	M.J. TEE, 20"X20"X12"	EACH
710219	M.J. TEE, 20"X20"X20"	EACH
710220	M.J. TEE, 24"X24"X12"	EACH
710221	M.J. TEE, 4"X4"X1 1/2"	EACH
710222	M.J. TEE, 4"X4"X2"	EACH
710223	M.J. TEE, 4"X4"X4"	EACH
710224	M.J. TEE, 6"X6"X6"	EACH
710225	M.J. TEE, 8"X8"X6"	EACH
710226	M.J. WYE, 6"X6"X6"	EACH
710227	OFFSET 6"X6"	EACH
710228	PRESSURE REDUCING VALVE	EACH
710229	PVC BENDS 45 DEGREES, 2"	EACH
710230	PVC REDUCER, 4"X12"	EACH
710231	PVC RESTRAINER, 12"	EACH
710232	PVC SERVICE LINE, CLASS 200, 2"	LF
710233	REDUCER, 10"X6"	EACH
710234	RESILIENT WEDGE VALVE, 6"	EACH

710235	RESILIENT WEDGE VALVE, 8"	EACH
710236	RESILIENT WEDGE VALVE, 10"	EACH
710237	RESILIENT WEDGE VALVE, 12"	EACH
710238	RETAINER GLAND, 4"	EACH
710239	RETAINER GLAND, 6"	EACH
710240	RETAINER GLAND, 8"	EACH
710241	RETAINER GLAND, 10"	EACH
710242	RETAINER GLAND, 12"	EACH
710243	RETAINER GLAND, 16"	EACH
710244	RETAINER GLAND, 24"	EACH
710245	SOLID SLEEVE, 4"	EACH
710246	SOLID SLEEVE, 6"	EACH
710247	SOLID SLEEVE, 8"	EACH
710248	SOLID SLEEVE, 10"	EACH
710249	SOLID SLEEVE, 12"	EACH
710250	SPLIT SLEEVE, 12"	LF
710251	SOLID SLEEVE, 24"	EACH
710252	TEE, 4"X4"X2"	EACH
710253	TEE, 4"X2"X4"	EACH
710254	TEE, 6"X6"	EACH
710255	TEE, 8"X6"	EACH
710256	TEE, 8"X8"	EACH
710257	TEE, 8"X8"X4"	EACH
710258	TEE, 10" X 10"	EACH
710259	TEE, 10"X10"X6"	EACH
710260	TEE, 10"X10"X8"	EACH
710261	TEE, 10"X10"X4"	EACH
710262	TEE, 12"X12"	EACH
710263	TEE, 12"X4"	EACH
710264	TEE, 12"X6"	EACH
710265	TEE, 16"X6"	EACH
710266	TEE, 16"X8"	EACH
710267	TEE, 16"X12"	EACH
710268	TEE, 12"X12"X8"	EACH
710269	TEE, 16"X16"X6"	EACH
710270	TEE, 16"X16"X8"	EACH
710271	TEE, 16"X16"X12"	EACH
710272	TEE, 16"X16"X16"	EACH
710273	TEE, 20"X20"X20"	EACH
710274	TEE, 24"X24"X16"	EACH
710275	TEE, 24"X24"X24"	EACH
710276	TRANSITION COUPLING, 8"	EACH

710350	BORE 12" STEEL PIPE CASING	LF
710351	BORE 16" STEEL PIPE CASING	LF
710352	BORE 18” STEEL PIPE CASING	LF
710353	BORE 20" STEEL PIPE CASING	LF
710354	BORE 24" STEEL CASING PIPE	LF
710355	BORE 28" STEEL PIPE CASING	LF
710356	BORE 30" STEEL PIPE CASING	LF
710357	BORE 36" STEEL PIPE CASING	LF
710358	BORE 42" STEEL PIPE CASING	LF
710359	BORE 48" STEEL PIPE CASING	LF
710360	GALVANIZED STEEL PIPE SERVICE LINE, SCHEDULE 40, 2"	EACH
710361	INSTALL STEEL CASING PIPE, 12"	LF
710362	INSTALLING STEEL PIPE, 20"	LF
710363	INSTALLING STEEL PIPE, 24"	LF
710364	PLACE 16" STEEL PIPE CASING	LF
710365	PLACE 18” STEEL PIPE CASING	LF
710366	PLACE 20" STEEL PIPE CASING	LF
710367	PLACE 24" STEEL PIPE CASING	LF
710368	PLACE 30" STEEL PIPE CASING	LF
710369	PLACE 42" STEEL PIPE CASING	LF
710370	STEEL CASING PIPE, 4”	LF
710371	STEEL CASING PIPE, 6"	LF
710372	STEEL CASING PIPE, 8"	LF
710373	STEEL CASING PIPE, 10"	LF
710374	STEEL CASING PIPE, 12"	LF
710375	STEEL CASING PIPE, 14"	LF
710376	STEEL CASING PIPE, 16"	LF
710377	STEEL CASING PIPE, 16", SANITARY SEWER	LF
710378	STEEL CASING PIPE, 18"	LF
710379	STEEL CASING PIPE, 20"	LF
710380	STEEL CASING PIPE, 24"	LF
710381	STEEL CASING PIPE, 24", SANITARY SEWER	LF
710382	STEEL CASING PIPE, 26"	LF
710383	STEEL CASING PIPE, 28"	LF
710384	STEEL CASING PIPE, 30"	LF
710385	STEEL CASING PIPE, 32"	LF
710386	STEEL CASING PIPE, 36"	LF
710387	STEEL CASING PIPE, 48"	LF
710388	STEEL CASING PIPE, 60"	LF
710389	STEEL CASING PIPE, 54"	LF
710390	STEEL PIPE , SPECIAL, SCHEDULE 40, 2"	LF
710391	STEEL PIPE GATE VALVE, 4" WITH C.J. BOX AND COVER	EACH

710392	STEEL PIPE, SPECIAL, SCHEDULE 40, 4"	LF
710393	STEEL PIPE, SPECIAL, SCHEDULE 40, 6"	LF
710394	STEEL SPIRAL RIB PIPE, 15"	LF
710395	STEEL SPIRAL RIB PIPE, 18"	LF
710396	STEEL SPIRAL RIB PIPE, 20" X16"	LF
710397	STEEL SPIRAL RIB PIPE, 24"	LF
710398	STEEL SPIRAL RIB PIPE, 33" X26"	LF
710399	STEEL SPIRAL RIB PIPE, 42"	LF
710400	STEEL SPIRAL RIB PIPE, 60"X46"	LF
710401	STEEL SPIRAL RIB PIPE, 72"	LF
710405	3/4" POLYETHYLENE SERVICE LINE, CLASS 160	LF
710406	1" POLYETHYLENE SERVICE LINE, CLASS 160	LF
710407	2" POLYETHYLENE SERVICE LINE, CLASS 160	LF
710408	3" POLYETHYLENE SERVICE LINE, CLASS 160	LF
710409	4" POLYETHYLENE SERVICE LINE, CLASS 160	LF
710410	3/4" CURB STOP, WITH C.I. COVER	EACH
710411	CONCRETE METER BOX WITH C.I. COVER, 18"X36"	EACH
710412	CORPORATION STOPS, 3/4"	EACH
710413	CORPORATION STOPS, 1"	EACH
710414	CORPORATION STOPS, 1 1/4"	EACH
710415	CORPORATION STOPS, 1 1/2"	EACH
710416	CORPORATION STOPS, 2"	EACH
710417	CURB STOPS, 3/4" X 3/4"	EACH
710418	CURB STOPS, 1 1/2"X1 1/2"	EACH
710419	CURB STOPS, 1"X1"	EACH
710420	CURB STOPS, 2"X2"	EACH
710421	GALVANIZED STEEL PIPE SERVICE LINE, SCHEDULE 40, 2"	EACH
710422	TYPE K COPPER SERVICE, 3/4"	LF
710423	PVC SERVICE LINE, CLASS 200, 1"	LF
710424	PVC SERVICE LINE, CLASS 200, 1 1/2"	LF
710425	PVC SERVICE LINE, COUPLING, 1"	EACH
710426	TYPE K COPPER SERVICE,1"	LF
710427	TYPE K COPPER SERVICE, 1 1/4"	LF
710428	TYPE K COPPER SERVICE, 1 1/2"	LF
710429	TYPE K COPPER SERVICE, 2"	LF
710430	TYPE K COPPER SERVICE, 3/4" W/2" STEEL CASING	LF
710431	TYPE K COPPER SERVICE, 2" W/4" STEEL CASING	LF
710435	FIRE HYDRANT EXTENSION, 6"	EACH
710436	FIRE HYDRANT EXTENSION, 12"	EACH
710437	FIRE HYDRANT REMOVAL	EACH
710438	FIRE HYDRANTS	EACH
710439	HYDRANT TEE, 6"X6"	EACH

710440	HYDRANT TEE, 8"X6"	EACH
710441	HYDRANT TEE, 10"X6"	EACH
710442	HYDRANT TEE, 12"X6"	EACH
710443	HYDRANT TEE, 16"X6"	EACH
710444	HYDRANT TEE, 20"X6"	EACH
710445	HYDRANT TEE, 24"X6"	EACH
710450	CURB BOX	EACH
710451	RELOCATING CURB BOX	EACH
710452	SLIDING TYPE CURB BOX	EACH
710453	VALVE BOX EXTENSION	EACH
710454	VALVE BOX, 3 PC	EACH
710460	TAPPING SLEEVE AND VALVE, 6"X6"	EACH
710461	TAPPING SLEEVE AND VALVE, 8"X6"	EACH
710462	TAPPING SLEEVE AND VALVE, 8"X8"	EACH
710463	TAPPING SLEEVE AND VALVE, 8"X12"	EACH
710464	TAPPING SLEEVE AND VALVE, 10"X10"	EACH
710465	TAPPING SLEEVE AND VALVE, 10"X6"	EACH
710466	TAPPING SLEEVE AND VALVE, 10"X8"	EACH
710467	TAPPING SLEEVE AND VALVE, 10" X10"	EACH
710468	TAPPING SLEEVE AND VALVE, 10"X12"	EACH
710469	TAPPING SLEEVE AND VALVE, 12"X12"	EACH
710470	TAPPING SLEEVE AND VALVE, 12"X16"	EACH
710471	TAPPING SLEEVE AND VALVE, 16"X6"	EACH
710472	TAPPING SLEEVE AND VALVE, 16"X16"	EACH
710473	TAPPING SLEEVE AND VALVE, 20"X20"	EACH
710474	TAPPING SLEEVE AND VALVE, 24"X16"	EACH
710480	AIR RELEASE VALVE AND ASSEMBLY	EACH
710481	ANTI-SEEP COLLAR	EACH
710482	BASIN RISER	EACH
710483	BLOW OFF ASSEMBLY	EACH
710484	BYPASS PUMPING OPERATION	EADY
710485	DEWATERING RISER	EACH
710486	DISINFECTION TAP	EACH
710487	METER AND METER YOKE, 1"X1"	EACH
710488	METER YOKE, 3/4"X5/8"	EACH
710489	MICRO-TUNNELING	LF
710490	PVC METER BOX WITH C.I. COVER, 18"X24"	EACH
710491	RELOCATING WATER METER	EACH

SECTION 711 – SANITARY SEWER SYSTEM

711.01 Description.

Furnish, transport, install and test a sanitary sewer system in accordance with the Contract Documents and as directed by the Engineer. Adjust or relocate existing sanitary sewers and connections to locations shown in the Contract Documents and abandonment of existing sanitary sewers. Perform the Work in accordance with the Contract Documents and the requirements of the standards and specifications of the owner of the Utility ("Owner"). In cases of conflict between the Contract Documents and the standards and specifications of the Owner; the standards and specifications of the Owner will govern the Work.

711.02 Materials.

Use Materials specified in the Contract Documents and as specified by the Owner's standard specifications. The Owner will have right to inspect Materials and reject any Materials that do not meet the applicable standards and specifications.

Provide all Materials to complete the Work including pipe, fittings and all other appurtenances necessary to make permanent connections to existing utility facilities of whatever material type encountered.

Use printed polyethylene plastic warning tape for sanitary sewer or force main with a metallic core, manufactured specifically for identifying buried utility lines. Use tape of a roll type, 6 inch minimum width and color coded for sewer (green) with warning and identification imprinted in bold black letters continuously and repeatedly over the entire length of the tape. Use code and letter color that is permanent and unaffected by moisture and other substances contained in trench backfill Materials. Imprint "Sanitary Sewer" on the tape or a similar message approved by the Engineer.

Use Class B Concrete for thrust blocks and clean-outs meeting the requirements of Section 1022.

Use Borrow, Type C for backfilling conforming to the requirements of Section 1001.

Use Graded Aggregate, Type B in accordance with Section 1005 to construct pipe bedding.

Unless shown otherwise in the Contract Documents or required by the Owner, use the same class of Material as the sewer mains to which they are connected for the construction of all commercial, industrial and residential connections.

711.03 Construction.

711.03.1 Special Requirements.

Coordinate all sanitary sewer construction activities with the Owner including, but not limited to, requests for system shut downs and inspections. Provide the Owner with reasonable time to respond to requests for information and coordination. Submit (3 weeks prior to beginning any Work) for approval of a plan describing the logical sequence for sanitary sewer shut-downs and tie-ins.

If necessary, furnish, install and remove bypass and temporary service pipes to maintain sanitary sewer service to customers during the Work. Furnishing, installing services and other branches, maintaining, providing safety precautions and removal of temporary services is the responsibility of the Contractor. Obtain written approval from the utility owner prior to interrupting temporary connections or new facilities of existing sanitary or combined sewers.

All modifications to existing services (commercial, industrial, and residential), as required by the present standards and specifications of the Owner and all relocations of such services necessary to avoid conflicts with Utilities and highway drainage facilities are included in the Work. Since the exact locations of the conflicts cannot be determined prior to trench excavation operations, the Contractor must coordinate and schedule any required relocation efforts of each sanitary sewer connection on an individual basis with the utility Owner and the property owner.

It is of prime importance that the Contractor, in the performance of the Work, does not disrupt the operation of the existing sanitary sewer facilities in any manner or at any time, without the expressed prior approval of the Owner. Construct, maintain and remove following construction such temporary sanitary sewer bypasses as may be required

during construction to maintain sanitary sewer service. No separate payment will be made for such temporary bypasses.

Any and all emergency repairs required are the responsibility of the Contractor. Upon notification via telecommunication from the Owner, attend to any repairs immediately. In the event the Owner is unable to contact the Contractor or the Contractor fails to make the emergency repairs in a length of time determined by the Owner, the Owner reserves the right to attend to any or all emergency repair work. In such a case, the Contractor is responsible for reimbursements due to the Owner for the costs of the repairs.

All Materials and Work are subject to inspection by the Owner and the Engineer. Remove and replace all unsatisfactory Materials, Work or parts thereof at the Contractor's expense.

711.03.2 Excavation and Installation.

Perform the excavation and backfill for sanitary sewer pipe and connections in accordance with the applicable requirements of Section 207 including backfill requirements of Section 207.03.D. Backfill using Borrow, Type C or existing Material meeting Borrow, Type C the entire depth of trench up to the bottom of patching Materials under existing and proposed roadways and shoulders. In areas outside of the roadway or proposed roadway including shoulders, place Borrow, Type C Material at least one foot above the top of the sewer line. Excavated Material may be used for backfill above the Borrow, Type C in areas outside of roadway and shoulders provided that the excavated Material is dry and free of organic material.

Lengths of pipes shown in the Contract Documents are estimated only. The Contractor is responsible to layout the tie-in areas in the field and fabricate the bends and pipe lengths required to properly tie-in to other pipes, fittings and/or manholes as required and approved by the Engineer.

Thoroughly clean all pipes and connecting Materials before placement. Keep all pipes and connecting Materials clean until the completed Work is accepted.

Install sheeting, shoring or an approved steel trench box to meet all applicable OSHA safety requirements.

During backfill of the sewer or force main, install the specified warning tape at a depth of 8 inches to 12 inches below finished grade or as directed and approved by the Engineer or Owner.

Do not place pipe or connections on a foundation into which frost has penetrated nor at any time when the Engineer deems that there is danger of the formation of ice or the penetration of frost at the bottom of the excavation, unless the minimum length of open trench and promptness of backfilling are observed.

Prior to constructing the tie-ins under this Section, coordinate with the Owner and, if required by the Owner, be prepared with tanker trucks and pumps to handle any excess flow during the transition. The Owner must be satisfied with the Equipment and tanker trucks provided on site before allowing the actual tie-in. Pump all excess flow into the tankers and properly dispose of the excess flow at an approved location.

711.03.3 Acceptance Testing.

Prior to the request for inspection by the Engineer, examine all completed pipe lines and connections to insure that they are placed to the proper alignment and grade and free from foreign material. After the examination has been completed to the satisfaction of the Engineer, the Engineer will order tests to be made on all portions of the sewers constructed.

Cooperate and furnish all assistance necessary to perform the tests as specified herein and as further required and directed by the Engineer and the representative of the Owner.

Furnish all Equipment and personnel to conduct the tests specified herein and/or any proposed by the Owner of the utility.

Do not make connections to existing sanitary sewers until after the final inspection and tests have been approved. Furnish all Material and labor required for tests, including caps and plugs and the cost thereof included in the prices bid for installing sanitary pipe. Furnish water required for leakage test at no additional cost to the Department.

711.04 Method of Measurement.

The quantity of the respective sanitary sewer system Items will be measured either by linear foot or each, as

installed and accepted. Adjustment of sanitary sewer laterals will be measured as the actual number of laterals adjusted and accepted.

Provide Breakout Sheets for those Items listed to be lump sum Items.

711.05 Basis of Payment.

Price and payment for sanitary sewer system Items, including adjustment of sanitary sewer laterals, includes furnishing, transporting and installing the Materials; testing of the sanitary sewer system; connecting to existing sanitary sewer systems and services; maintaining service as required; excavating; disposing of excess excavated Material; backfilling; furnishing Material for backfilling; furnishing and placing warning tape; furnishing and installing concrete thrust blocks, joint restraints, aggregate pipe bedding, sheeting and shoring, temporary support of existing Utilities, dewatering, furnishing and using tanker trucks for excess flow, disposing of excess flow at an approved location; abandoning existing pipes including filling such pipes with flowable fill, cutting and capping new or existing lines and for all labor, Equipment, tools and necessary incidentals to achieve and accept an operational sanitary sewer system.

ITEM	DESCRIPTION	UNIT
711001	ADJUST SANITARY SEWER LATERALS	EACH
711002	SANITARY SEWER SYSTEM	LS
711003	SANITARY AND WATER FACILITY	LS
711004	SEWER FORCE MAIN AIR RELEASE VALVE AND ASSEMBLY, 2"	EACH
711005	ADJUST / RELOCATE FORCE MAIN	LS
711006	SANITARY FORCE MAIN AND ACCESSORIES	LS
711007	INSTALLING SANITARY SEWER, PVC, 4"	LF
711008	INSTALLING SANITARY SEWER, PVC, 6"	LF
711009	INSTALLING SANITARY SEWER, PVC, 8"	LF
711010	INSTALLING SANITARY SEWER, PVC, 10"	LF
711011	INSTALLING SANITARY SEWER, PVC, 12"	LF
711012	INSTALLING SANITARY SEWER, PVC, 15"	LF
711013	INSTALLING SANITARY SEWER, PVC, 18"	LF
711014	INSTALLING SANITARY SEWER, PVC, 21"	LF
711015	INSTALLING SANITARY SEWER, PVC, 24"	LF
711016	INSTALLING SANITARY SEWER, DIP, 4"	LF
711017	INSTALLING SANITARY SEWER, DIP, 6"	LF
711018	INSTALLING SANITARY SEWER, DIP, 8"	LF
711019	INSTALLING SANITARY SEWER, DIP, 8" W/ BOLTLESS RESTRAINED JOINTS	LF
711020	INSTALLING SANITARY SEWER, DIP, 10"	LF
711021	INSTALLING SANITARY SEWER, DIP, 12"	LF
711022	INSTALLING SANITARY SEWER, DIP, 16"	LF
711023	INSTALLING SANITARY SEWER, DIP, 18"	LF
711024	INSTALLING SANITARY SEWER, DIP, 24"	LF
711025	INSTALLING SANITARY SEWER, DIP, 24", W/ BOLTLESS RESTRAINED JOINTS	LF
711026	INSTALLING SANITARY SEWER, DIP, 30"	LF
711027	INSTALLING SANITARY SEWER, DIP, 42"	LF
711028	INSTALLING SANITARY SEWER, RCP, 24"	LF
711029	INSTALLING SANITARY SEWER, RCP, 30"	LF
711030	INSTALLING SANITARY SEWER (FORCE MAIN), PVC, 1 1/2"	LF
711031	INSTALLING SANITARY SEWER (FORCE MAIN), PVC, 2"	LF

711032	INSTALLING SANITARY SEWER (FORCE MAIN), PVC, 2 1/2"	LF
711033	INSTALLING SANITARY SEWER (FORCE MAIN), PVC, 3"	LF
711034	INSTALLING SANITARY SEWER (FORCE MAIN), PVC, 4"	LF
711035	INSTALLING SANITARY SEWER (FORCE MAIN), PVC, 6"	LF
711036	INSTALLING SANITARY SEWER (FORCE MAIN), PVC, 8"	LF
711037	INSTALLING SANITARY SEWER (FORCE MAIN), DIP, 4"	LF
711038	INSTALLING SANITARY SEWER (FORCE MAIN), DIP, 6"	LF
711039	INSTALLING SANITARY SEWER (FORCE MAIN), DIP, 8"	LF
711040	INSTALLING SANITARY SEWER (FORCE MAIN), DIP, 10"	LF
711041	INSTALLING SANITARY SEWER (FORCE MAIN), DIP, 12"	LF
711042	INSTALLING SANITARY SEWER (FORCE MAIN), DIP, 24"	LF
711043	INSTALLING SANITARY SEWER (FORCE MAIN), DIP 30"	LF
711044	INSTALLING SANITARY SEWER (FORCE MAIN) BY BORING, PE, 2"	LF
711045	INSTALLING SANITARY SEWER (FORCE MAIN) BY BORING, PE, 4"	LF
711046	INSTALLING SANITARY SEWER (FORCE MAIN) BY BORING, PE, 6"	LF
711047	INSTALLING SANITARY SEWER (FORCE MAIN) BY BORING, PE, 10"	LF
711048	INSTALLING SANITARY SEWER (FORCE MAIN), HDPE, 8"	LF

SECTION 720 – GUARDRAIL

720.01 Description. Furnish and install guardrail systems, guardrail-over-culverts or guardrail components in accordance with the Contract Documents and as directed by the Engineer. Guardrail systems include posts, offset blocks and rail components. End treatments and transition elements are covered under applicable sections of the Standard Specification.

720.02 Materials. Furnish guardrail systems that have been tested in conformance with the requirements of National Cooperative Highway Research Program (NCHRP) Report 350 or the Manual on Assessing Safety Hardware (MASH) published by the American Association of State Highway and Transportation Officials (AASHTO). Use the latest edition of each manual available at the time of Project advertisement. Submit, for approval, shop drawings and Federal Highway Administration (FHWA) acceptance letter(s) for guardrail systems or individual components.

Furnish guardrail Materials conforming to the requirements below:

A.	Portland Cement Concrete, Class B	Section 1022
B.	Steel posts, steel shapes	Section 1070
C.	Galvanized W-beam guardrail	Section 1070
D.	Guardrail Hardware	Section 1070
E.	Rods and turnbuckles	Section 1070
F.	Guardrail reflectors	Section 1070
G.	Timber posts	Section 1070
H.	Offset blocks	
	a. Wood offset blocks	Section 1070
	b. Recycled Composite Material Offset Blocks	
	i. As specified by the manufacturer	
	ii. Meets NCHRP Report 350 or MASH testing requirements	
I.	Galvanized steel rub rail	Section 1070
J.	Galvanized Thrie Beam guardrail	Section 1070

720.03 Construction. If required by the Engineer or by a note in the Plans, conduct a pre-installation field meeting prior to installation of guardrail systems. The purpose of the meeting is to discuss existing field conditions, guardrail placement, grading requirements and end treatment installation.

720.03.1 Post Installation: Perform test pits to determine utility conflicts prior to post placement when necessary or when required by the Engineer, in accordance with Section 204. Drive all posts, unless otherwise approved by the Engineer. Use a method of driving that will not batter or distort the posts. If posts are not driven, set them in holes of sufficient diameter to allow tamping of the backfill. Backfill with approved material. Place backfill in horizontal layers not exceeding 6-inches loose depth and thoroughly compact. Prior to installing rail elements, properly align the posts to within 1/4-inch of line and grade. Install all posts plumb. Repair, in accordance with Section 402, any broken bituminous concrete that cracks or breaks as a result of installing guardrail posts.

720.03.2 Rail Assembly: Furnish rail elements as specified. Ensure a smooth continuous installation, with laps in the direction of traffic flow for the closest lane. Ensure that all bolts, except those through expansion joints, are drawn tight. Tighten bolts through expansion joints as tight as possible without preventing the beams from sliding past one another longitudinally. Bolts shall extend at least 1/4-inch beyond the nuts. Bolts which are necessary for adjustment shall not extend more than 1/2-inch beyond the nuts. Burr the last thread of post railing bolts to prevent removal of such bolts.

720.03.3 Offset Blocks: When installing new W-beam guardrail, use either wood or approved recycled composite offset blocks of the appropriate depth required for the specific system being installed. Do not mix different types of manufactured composite blocks or mix composite and wood blocks. Installation of the composite offset blocks is not permitted at wood posts.

Notch wood offset blocks in accordance with the Standard Construction Details only when installing on steel posts. When wood offset blocks are installed on wood posts, it is not necessary to notch the offset blocks; in this case, toenail the wood offset block in place using a three (3) inch long ceramic coated screw, placed such that the screw penetrates both the wood offset block and wood post.

Install approved recycled composite offset blocks in accordance with the manufacturer's recommendations and without modifying in any manner whatsoever.

720.03.4 Guardrail Reflectors: Install guardrail reflectors in accordance with the Standard Construction Details. Guardrail reflector colors shall be as follows:

A. On any divided highway or one-way roadway/ramp, the surface facing traffic shall have white or silver reflective sheeting on the right side of the roadway and yellow reflective sheeting on the left side of the roadway. The back surface of all of the reflectorized washers shall have red reflective sheeting.

B. On any undivided highway, all guardrail reflector surfaces shall have white or silver reflective sheeting on the front and back.

C. Provide reflective sheeting meeting the requirements of ASTM D4956 Type IV

720.03.5 Relocating Guardrail: Remove existing guardrail, exercising every precaution to avoid and/or minimize damage to the guardrail system. Replace all nuts, bolts, washers and other hardware/accessories with new hardware/accessories. The cost of furnishing and installing any new hardware/accessories shall be include in the Unit Bid Price for this item. If, in the opinion of the Engineer, damage to the existing guardrail system was caused due to the negligence of the Contractor, the Contractor shall replace the damaged components at no cost to the Department.

Reinstall and reset the guardrail system in the locations designated on the Plans in accordance with Section 720.03 of this specification and the applicable Standard Construction Details. If the guardrail to be relocated consists of steel offset blocks, replace the existing steel offset blocks with offset blocks meeting the requirements of Section 720.02 and the applicable Standard Construction Details. No separate payment will be made for the new offset blocks. Install new guardrail reflectors in accordance with Section 720.03.04 of this specification and the applicable Standard Construction Details.

720.03.5 Guardrail Mounted Railing. Furnish and install railing, attachment hardware, and the start and end sections in accordance with the Contract Documents.

720.04 Method of Measurement. Guardrail will be measured as the number of linear feet of guardrail furnished, installed, complete in place and accepted. Guardrail will be measured from the center of end post to the center of end post, excluding barrier connections and end treatments.

Guardrail components will be measured as the number of each component furnished, installed, complete in place and accepted.

Guardrail-over-culverts will be measured as the number of each furnished, installed, complete in place and accepted.

Relocated guardrail will be measured as the number of linear feet of guardrail relocated, complete in place and accepted.

Guardrail mounted railing will be measured as the number of linear feet of railing furnished, installed, complete in place and accepted.

720.05 Basis of Payment. The quantity of guardrail, guardrail components, guardrail mounted railing, or guardrail-over-culverts will be paid for at the Contract Unit Price as specified in the table below.

For new guardrail installations, price and payment will constitute full compensation for furnishing and installing rail elements, posts, offset blocks, hardware, required transition sections and guardrail reflectors, guardrail mounted

railing, for burring of bolts, for excavating, backfilling, compacting and disposing of surplus Materials, for patching bituminous concrete around posts, for the pre-installation field meeting and for all labor, Equipment, tools and incidentals required to complete the Work.

When specified in the Plans to replace individual components, price and payment will constitute full compensation for furnishing and installing the applicable components, for burring of bolts, for excavating, backfilling, compacting and disposing of surplus material, for patching bituminous pavement around posts and for all labor, Equipment, tools and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
720001	GALVANIZED STEEL BEAM GUARDRAIL (WOOD POST)	LF
720002	GUARDRAIL TO BRIDGE GUARDRAIL TRANSITION	LF
720003	BRIDGE GUARDRAIL	LF
720004	STEEL RAIL ELEMENT, STRAIGHT	LF
720005	STEEL RAIL ELEMENT, CURVED	LF
720006	GALVANIZED STEEL POSTS	EACH
720007	SHORT WOOD BREAKAWAY POST, TREATED	EACH
720008	TREATED WOOD BLOCK	EACH
720009	TERMINAL CONNECTOR, BRIDGE AND BARRIER	EACH
720010	GALVANIZED RAIL ELEMENT, THRIE BEAM	EACH
720011	GALVANIZED TRANSITION SECTION, THRIE BEAM	EACH
720012	GALVANIZED STEEL POST, THRIE BEAM	EACH
720013	GALVANIZED STEEL BRACKET, THRIE BEAM	EACH
720014	BRIDGE RAIL RETROFIT, TYPE 1	LF
720015	BRIDGE RAIL RETROFIT, TYPE 2	LF
720016	BRIDGE RAIL RETROFIT, TYPE 3	LF
720017	GALVANIZED RAIL ELEMENT	EACH
720018	GALVANIZED STEEL POST, 7'	EACH
720019	GALVANIZED STEEL POST, 8'	EACH
720020	REFLECTORIZED WASHERS	EACH
720021	GALVANIZED STEEL BEAM GUARDRAIL, TYPE 1-31	LF
720022	GALVANIZED STEEL BEAM GUARDRAIL, TYPE 2-31	LF
720023	GALVANIZED STEEL BEAM GUARDRAIL, TYPE 3-31	LF
720024	GUARDRAIL OVER CULVERTS, TYPE 1-31	EACH
720025	GUARDRAIL OVER CULVERTS, TYPE 2-31	EACH
720026	GUARDRAIL OVER CULVERTS, TYPE 3-31	EACH
720027	TREATED WOOD GUARDRAIL POST	EACH
720028	CURVED GUARDRAIL SECTION	LF
720029	BRIDGE RAIL RETROFIT, TYPE 4	LF
720030	RELOCATING GUARDRAIL	LF

ITEM	DESCRIPTION	UNIT
720031	GUARDRAIL MOUNTED RAILING	LF
720032	REMOVE AND RESET GALVANIZED STEEL POST AND OFFSET BLOCK	EACH
720033	OFFSET BLOCKS	EACH

SECTION 721 – GUARDRAIL END SECTIONS AND TRANSITIONS

721.01 Description. Furnish and install crashworthy guardrail end treatments, end anchorages, buried end sections, guardrail-to-barrier connections and/or guardrail transition sections in accordance with the Contract Documents and as directed by the Engineer.

721.02 Materials.

721.02.1 Guardrail End Treatment. Furnish guardrail end treatment that has been tested in conformance with the requirements of NCHRP Report 350 or MASH for the location depicted on the Plans and design speed of the roadway. Submit, for approval, manufacturer's certification, manufacturer's installation instructions and FHWA acceptance letter(s) for the end treatment system prior to installation. Guardrail end treatment designs shall be as follows:

A. Type 1 – parallel end treatment

B. Type 2 – flared end treatment

C. Type 3 – median end treatment

D. Type 4-27 – flared end treatment (used only with 27-inch height guardrail systems)

Provide retroreflective Material on the nose of the guardrail end treatment as follows:

A. Type 1 – minimum of 2 square feet

1. A striped marker consisting of ASTM D4956 Type IV sheeting with alternating black and retroreflective yellow stripes sloping downward at an angle of 45-degrees toward the side of the end treatment on which traffic is to pass.

B. Type 2 - minimum of 3 square feet

1. A striped marker consisting of ASTM D4956 Type IV sheeting with alternating black and retroreflective yellow stripes sloping downward at an angle of 45-degrees toward the side of the end treatment on which traffic is to pass.

C. Type 3 - minimum of 3 square feet

1. A marker consisting of ASTM D4956 Type IV retroreflective yellow sheeting covering the nose of the end treatment

D. Type 4-27 – minimum of 3 square feet

1. A striped marker consisting of ASTM D4956 Type IV sheeting with alternating black and retroreflective yellow stripes sloping downward at an angle of 45 degrees toward the side of the end treatment on which traffic is to pass.

721.02.2 Guardrail End Anchorage. Furnish guardrail end anchorage components and associated Materials in accordance with Section 720.02.

721.02.3 Buried End Section. Furnish buried end section components and associated Materials in accordance with Section 720.02.

721.02.4 Guardrail-to-Barrier Connection. Furnish guardrail-to-barrier connection (approach type or exit type) components and associated Materials in accordance with Section 720.02.

721.03 Construction. If required by the Engineer or by a note in the Plans, conduct a pre-installation field meeting prior to installation of guardrail systems. The purpose of the meeting is to discuss existing field conditions, guardrail placement, grading requirements and end treatment installation.

721.03.1 Guardrail End Treatment. Assemble and install the guardrail end treatment as specified by the manufacturer and in accordance with the Standard Construction Details. In case of a conflict between the manufacturer's recommendations and the Standard Construction Details, follow the manufacturer's recommendations. Perform grading in accordance with the Standard Construction Details for the length of the end

treatment. Do not install guardrail reflectors on the end treatment unless specified by the manufacturer. Affix the required retroreflective Material to the nose of the guardrail end treatment.

721.03.2 Guardrail End Anchorage. Install guardrail end anchorages in accordance with the Standard Construction Details at the locations indicated on the Plans. Construct end anchorages using applicable construction methods provided in Section 720.

721.03.3 Buried End Section. Install buried end sections in accordance with the Standard Construction Details at the locations indicated on the Plans. Construct buried end sections using applicable construction methods provided in Section 720. Perform grading in accordance with the Standard Construction Details.

721.03.4 Guardrail-to-Barrier Connection. Install approach type and/or exit type guardrail-to-barrier connections in accordance with the Standard Construction Details at the locations indicated on the Plans. Construct guardrail-to-barrier connections using applicable construction methods provided in Section 720. 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. Fill any existing holes in concrete barrier with non-shrink grout.

721.04 Method of Measurement.

721.04.1 Guardrail End Treatment. Measure the quantity of guardrail end treatments as the number of guardrail end treatments furnished, assembled, installed, complete-in-place and accepted. Measurement limits will be as defined in the Standard Construction Details for the type of end treatment installed. Measurement will begin at the center of the nose post and extend back along the end treatment and guardrail to which it is attached. Any guardrail within the length specified in the Standard Construction Details will be considered as part of the end treatment and not be measured separately. Measurement for the guardrail will begin at the distance specified in the Standard Construction Details from the splice between the end treatment section and the normal guardrail section.

721.04.2 Guardrail End Anchorage. Measure the quantity of guardrail end anchorages as the number of guardrail end anchorages furnished, assembled, installed, complete-in-place and accepted.

721.04.3 Buried End Section. Measure the quantity of buried end sections as the number of buried end sections furnished, assembled, installed, complete-in-place and accepted.

721.04 Guardrail-to-Barrier Connection. Measure the quantity of guardrail-to-barrier connections as the number of guardrail-to-barrier connections furnished, assembled, installed, complete-in-place and accepted.

721.05 Basis of Payment.

721.05.1 Guardrail End Treatment. The quantity of guardrail end treatments will be paid for at the Contract Unit Price as specified in the table below. Price and payment will constitute full compensation for furnishing all Materials, fabrication and installation and for all Materials, labor, Equipment, tools and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
721000	GUARDRAIL END TREATMENT, TYPE 1-31, TEST LEVEL 2	EA
721001	GUARDRAIL END TREATMENT, TYPE 1-31, TEST LEVEL 3	EA
721002	GUARDRAIL END TREATMENT, TYPE 2-31, TEST LEVEL 2	EA
721003	GUARDRAIL END TREATMENT, TYPE 2-31, TEST LEVEL 3	EA
721004	GUARDRAIL END TREATMENT, TYPE 3-31	EA
721005	GUARDRAIL END TREATMENT, TYPE 4-27	EA

721.05.2 Guardrail End Anchorage. The quantity of guardrail end anchorages will be paid for at the Contract Unit Price as specified in the table below. Price and payment will constitute full compensation for furnishing all Materials, fabrication and installation and for all Materials, labor, Equipment, tools and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
721006	END ANCHORAGE 31	EA
721007	ENTRANCE SPECIAL END ANCHORAGE	EA

721.05.03 Buried End Section. The quantity of buried end sections will be paid for at the Contract Unit Price as specified in the table below. Price and payment will constitute full compensation for furnishing all Materials, fabrication and installation, excavation, constructing anchorage block, grading and for all Materials, labor, Equipment, tools and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
721008	BURIED END SECTION	EA

721.05.4 Guardrail-to-Barrier Connection. The quantity of guardrail-to-barrier connections will be paid for at the Contract Unit Price as specified in the table below. Price and payment will constitute full compensation for furnishing and placing all Materials, including reflectorized washers, for burring of bolts, excavating, backfilling, compacting and disposing of surplus Materials; for patching bituminous pavement around posts; for repairing any damage to the concrete barrier that resulted from the process of attaching the guardrail to the barrier, for filling any existing holes in the barrier with non-shrink grout; and for all labor, Equipment, tools and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
721009	GUARDRAIL TO BARRIER CONNECTION (EXIT TYPE 31)	EA
721010	GUARDRAIL TO BARRIER CONNECTION, APPROACH TYPE 1-31	EA
721011	GUARDRAIL TO BARRIER CONNECTION, APPROACH TYPE 2-31	EA
721012	GUARDRAIL TO BARRIER CONNECTION, APPROACH TYPE 3-31	EA

SECTION 722 – HIGH-TENSION CABLE BARRIER

722.01 Description. Furnish and install high-tension cable barrier, including all labor, Materials and appurtenances necessary for the complete and satisfactory construction of high tension cable barrier systems, including, but not limited to, training sessions, design and layout of steel posts, reinforced concrete socketed foundations, crashworthy end terminals, excavation and backfill, concrete anchors, all required connectors and hardware in accordance with the Contract Documents and as directed by the Engineer.

722.02 Materials. Certify that the high-tension cable barrier system and end terminals satisfy the National Cooperative Highway Research Program (NCHRP) Report 350 or Manual for Assessing Safety Hardware (MASH) for a Test Level 4 (TL-4) installation and is approved for use on the National Highway System. The system shall have been successfully tested to meet NCHRP-350 or MASH TL-4 requirements. Provide a FHWA letter of eligibility. Provide a high-tension cable barrier system consisting of a four (4) pre-stretched wire rope system with a maximum deflection of eight (8) feet. Use only one manufacturer's cable barrier system for the entire length of the Contract

722.02.01 Wire Rope. Wire ropes shall be a galvanized 3/4-inch diameter, 3 x 7 pre-stretched cable construction meeting AASHTO M30-92 (2000)/ASTM A741-98, Type I, Class A, coating with a minimum breaking strength of 39,000 pounds. The wire rope shall be pre-stretched during manufacture to exhibit a minimum modulus of elasticity (E) of 21,661,553 psi based on a steel surface area of a fixed 0.2394877 in^2. Test in accordance with ISO 12076-2002 Wire rope Modulus of Elasticity – "Initial (as manufactured)." No bedding of the rope is permitted during testing. Samples for proof-testing will be required to assure that wire ropes and connections meet or exceed the minimum breaking load for the rope. If the wire is not manufactured by the cable barrier system manufacturer, supply a separate certification from the wire rope manufacturer stating it meets the cable barrier manufacturer's requirements. Each cable spool shall specify breaking strength, modulus of elasticity and the amount of force used to stretch the wire rope.

722.02.02 Threaded Terminals. Furnish threaded terminals, factory applied swaged type, in accordance with the manufacturer's specifications. Threaded terminals shall be right hand (RH) or left hand (LH) threaded M 24 x 3 pitch to ANSI B 1.13 M. The body of the threaded terminal shall provide a minimum of 6-inches of wire rope penetration depth and fully fitted ropes shall develop a minimum breaking strength of 36,800 pounds. Threaded terminals shall be galvanized after threading, meeting the requirements of ASTM A-153. Use only one wedge threaded terminal (closed type only) per segment of cable barrier. A segment of cable barrier is defined by a continuous section of cable barrier from end terminal to end terminal.

722.02.03 Rigging Screws. Provide rigging screws or turnbuckles to allow for tensioning of the wire rope and which shall meet the requirements of ANSI B 1.13 M 24 x 3 to accept threaded rope terminals. The rigging screw shall be a closed body type with two (2) inspection holes to determined threaded rope terminal penetration, allowing for a minimum of six (6) inches of penetration from each end. Thread one end of the rigging screw with right-hand (RH) threads and thread the other end with left-hand (LH) threads. Rigging screws shall develop a minimum breaking strength of 36,800 pounds and shall be galvanized to ASTM A-153 after threading. For installations greater than 1,000 feet in length, provide at least one rigging screw per 1,000 feet per strand of wire rope. For installations less than 1,000 feet in length, include one rigging screw per strand near the center of the installation.

722.02.04 Tensile Rods. If tensile rods are part of the approved cable barrier system, provide tensile rods with combination mechanical fittings at the terminal ends of each wire rope. The combination mechanical fittings shall be of a cylindrical design into which the wire rope is inserted and threaded to accept the tensile rod. The fitting shall insure proper adjustment of the wire rope for length and shall develop a minimum breaking strength of the entire wire rope of 36,800 pounds.

722.02.05 Posts. Furnish steel posts in accordance with the manufacturer's specifications. Do not use steel yielding posts or I-post designs. Use socketed steel posts placed in reinforced concrete foundations utilizing a metal sleeve and meeting the requirements of the manufacturer's specifications and details. Cap the posts consistent with the post sizes and description as specified in the FHWA eligibility letter for the high-tension cable barrier system. Fabricate all posts from materials meeting the requirements of ASTM-36 and galvanized to ASTM A-123 requirements after fabrication. Posts shall be domestic cold-formed from hot-rolled mild steel of the size and shape

as specified by the manufacturer. All posts shall have a means of holding the wire ropes at the design height. Provide steel sockets in accordance with the manufacturer's specifications and set them in concrete foundations for insertion of the posts at installation. Fabricate sockets from minimum ten (10) gauge, hot-rolled, mild steel, galvanized to ASTM A-123 after fabrication. Provide a fitting gasket, profiled to fit tightly around each post, to prevent debris from entering the socket. Perform all required welding using a certified welder in accordance with AWS D1.1.

722.02.06 End Terminals. End terminals shall meet the requirements of NCHRP 350 or MASH, TL-3 as represented by crash testing in accordance with NCHRP 350 or MASH. Provide anchor fittings at the ends of each wire rope at the end terminal. Anchor each of the four (4) wire ropes directly to the end terminal independently. Fabricate end anchors and fittings from materials meeting ASTM A-36, galvanized to ASTM A-123 after fabrication, and shall be of the same size and type used in connection to the rigging screws. The end anchor fittings shall allow for infinite adjustment along the wire rope for proper length and shall develop a minimum breaking strength of 36,800 pounds along the entire rope. Perform all welding by using a certified welder in accordance with AWS D1.1.

722.02.07 Foundations. Construct steel reinforced, cast-in-place concrete foundations in excavations of natural undisturbed ground. Construct the foundations to the size and shape provided in accordance with the manufacturer's specifications and based on soil boring data. However, the minimum diameter shall be 14-inches and the minimum depth shall be 48-inches. The Contract Documents may include existing geotechnical information, but the Contractor is responsible to supply the manufacturer with the geotechnical information needed to design the cable barrier system. Use concrete meeting the requirements of Concrete Cement, Class A in Section 1022. Provide steel reinforcement based on the existing soil conditions and in accordance with the manufacturer's recommendations.

722.02.08 Post Delineation. Delineate high-tension cable barrier with retroreflective sheeting. Beginning with the first vertical line post in each direction of a cable barrier segment, delineate posts at intervals no greater than 50 feet on tangents and curves with a radius of 3,500 feet or greater and 30 feet on curves having a radius less than 3,500 feet. Delineate all end terminal posts in accordance with the manufacturer's recommendations. Delineation shall be visible from both directions of traffic unless otherwise shown on the Plans. Use delineation consisting of yellow retroreflective sheeting meeting the requirements of ASTM D4956 Type IX material. The minimum area of sheeting required on each post is eight (8) square inches. Attach the sheeting near the top of the post as recommended by the manufacturer. On posts with flat surfaces facing approaching traffic, the retroreflective sheeting may be applied directly to the post. On posts without flat surfaces facing approaching traffic, the sheeting may be applied to the post cap.

722.03 Construction.

722.03.1 Submittals. Prior to ordering any material and beginning any work, submit shop drawings in accordance with Section 105.04. Provide all pertinent working drawings, design calculations and erection methods for review and approval of the proposed high-tension cable barrier system. Any fabrication done prior to approval of the shop drawing submittal will be at the Contractor's own risk and may not be paid by the Engineer. Prepare and submit the working drawings, design calculations and erection methods for review and approval shortly after the Notice to Proceed. Any delay in submission and acceptance of a proposed design will not extend the contract time.

All design information shown on the Plans is conceptual. The manufacturer takes full responsibility for both the engineering and calculations and ensures that all design assumptions are presented in their drawings and specifications. The shop drawings and design calculations shall be sealed by a Professional Engineer licensed in the State of Delaware with experience in the design and construction of high-tension cable barrier systems and shall include a valid signature and current date signed. This submittal shall include, but not be limited to, the following information:

1. Design details, design dimensions and detailed specifications for proposed materials and the method of installation from the manufacturer prior to the bid, including recommended depths for line post concrete footings and concrete end-anchors. These design details, dimensions and specifications shall be based on the specific project location and requirements as shown on the Contract Drawings or specified herein.

Provide all geotechnical information along with any construction plans and details to the manufacturer for design of the line post concrete footings and concrete end-anchors.

2. Design calculations and notes, shop drawings, and construction specifications prepared by the manufacturer in accordance with Section 105.04 of the Standard Specifications. The shop drawings shall clearly depict the installation details for the proposed cable barrier system components, including line posts, concrete footings and concrete end terminals.

3. A copy of the NCHRP-350 or MASH certification/eligibility letter from FHWA for the proposed cable barrier system and end anchors.

4. Certification that all the materials are in accordance with the requirements of the Plans and Specifications. Provide certification that all steel used on the project is of United States origin and fabrication.

5. Complete design calculations substantiating that the proposed design satisfies the design parameters in the Plans and in these Specifications. This includes, but is not limited to, the factors of safety for overturning and pullout.

6. Other miscellaneous details or information required to address the layout and/or design of the high tension cable barrier system shown on the Plans, as required by the Specifications or requested by the Engineer.

7. Written certification from the manufacturer that the work force to be used for installing the system has received training and necessary aids to install the system. Do not begin work before submitting this certification. Supply a list of individuals that have been trained and certified by the manufacturer and will be performing the work.

Within ten (10) Days of the semi-final inspection, supply the following spare parts for the high tension cable barrier. Deliver the parts to the DelDOT maintenance facility as directed by the Engineer.

1. An extra supply of TL-4 line posts (socketed-type), including post hardware and accessories (caps, reflective sheeting, straps, spacers, and socket covers). This supply shall include 200 posts and accessories.

2. An extra supply of rigging screws and threaded terminals. This supply shall include enough materials to complete eight (8) turnbuckle assemblies.

3. An extra supply of anchor posts (socketed-type), including post hardware and accessories (caps, reflective sheeting, straps, fittings, spacers, and socket covers). This supply shall include enough materials to complete three (3) end anchor installations.

4. An extra supply of fitting gaskets or socket covers. This supply shall include 100 socket covers.

5. A tension meter kit and repair tool rope spreader. Provide one new, calibrated tension meter as part of the deliverables. The meter shall bear a serial number and be accompanied by a current Certificate of Calibration from a National Institute of Standards and Testing accredited laboratory.

722.03.2 Training. If required by a note in the Plans, provide on-site field instruction by the system manufacturer. Provide a minimum of two (2) training sessions: the installation training prior to beginning cable barrier construction and the maintenance training before final inspection. The duration of the training shall be established by the manufacturer and shall provide field training on all aspects of the system installation and maintenance. Coordinate the training schedule and location with the Engineer. The Engineer will advise the appropriate Department staff, including construction inspectors and maintenance personnel regarding training location and schedule. Course content and materials (handouts and trainer's reference works) shall be certified by the manufacturer as appropriate for their system. Present the certification letter to the Engineer a minimum of fourteen (14) days prior to holding the initial training session. Provide a hard copy and an electronic copy (PDF format) of the course materials on the day of the training.

722.03.3 Installation Training. Hold the installation training prior to the beginning of cable barrier construction. Submit the proposed date to the Engineer a minimum of 14 calendar days prior to the training session date for review and approval. At a minimum the training shall include the following participants:

1. Prime Contractor's Field Superintendent, or designated representative(s)
2. Cable Barrier Sub-Contractor's Field Supervisor, or designated representative(s)
3. Engineer's, designated representative(s) including the Project's construction inspectors

The Engineer will have final approval of participants. Provide every participant with a complete set of course handouts, the manufacturer's installation manual and the manufacturer's plans for the approved system. Cover all aspects of the system installation, including the following subjects:

1. Description and function of all system components
    a. Manufacturer's instructions and specifications for end anchor and post foundation installation, including, but not limited to foundation sizes, steel reinforcement, concrete design strength, curing time, concrete testing and locations
    b. Manufacturer's instructions and specifications for line post installation
    c. Manufacturer's instructions and specifications for end terminal assembly installation
    d. Manufacturer's instructions and specifications for wire rope installation and tensioning
2. Sequence of construction operations
3. Discussion of critical tasks
4. Installation inspection

722.03.4 Maintenance Training. Hold the maintenance training a minimum of seven (7) days prior to final inspection of the system. Submit the proposed date of training to the Engineer a minimum of 14 calendar days prior to the training session date for review and approval. The training shall have the following participants:

1. District Maintenance Engineer, or designated representative(s)
2. District Maintenance Superintendent, or designated representative(s)
3. Maintenance contractor field supervisor, or designated representative(s), if maintenance of system will be completed under an existing maintenance contract.
4. District maintenance personnel
5. Maintenance contractor personnel, if maintenance of system will be completed under an existing maintenance contract.

The Engineer will have final approval of participants. Provide every participant with a complete set of course handouts, the manufacturer's maintenance manual and the manufacturer's plans for the approved system. The training course and accompanying course material shall cover, at a minimum, the following subjects:

1. Description of the system components
2. Discussion of critical features
3. Inspection
    a. Median cable barrier
    b. Terminal assembly
4. Median cable barrier component replacement
5. Terminal assembly replacement
6. Cable tension monitoring and re-tensioning
7. End anchor reattachment
8. Freeing captured vehicles
9. Field splicing of cable

722.03.5 Installation. Prior to supplying and installing the high tension cable barrier, thoroughly review the Plans and, if appropriate, provide recommendations for adjusting the placement of the cable barrier based on details of their specific system. This may include anchor locations, length of need adjustments, possible extension of bridge or roadway median barrier, post type or spacing adjustments for roadway curvature, or post type or spacing

adjustments for reduced dynamic deflection. Coordinate with the Engineer to review plan details and required adjustments needed prior to ordering the cable.

Align and locate the cable barrier system in accordance with the Plans and manufacturer recommendations. The Contractor is responsible for all construction stake out for the line posts and end terminals. Notify the Engineer of any potential conflicts with underground utilities or drainage prior to construction. The Engineer may require the Contractor to excavate test pits to determine the exact location and depth of any existing utility that may conflict the proposed alignment of the high tension cable barrier system. The Contractor may need to adjust post spacing to avoid the conflicts with existing features and/or utilities while maintaining a maximum deflection of eight (8) feet.

Complete all clearing and grubbing and final grading prior to installation of each section of cable barrier post foundations, terminals, transitions or anchor system. If a bituminous pavement maintenance strip is required, complete final paving prior to excavation/drilling for post foundations.

Construct all foundations using cast-in-place, reinforced concrete per the manufacturer's specifications. Excavate a properly sized hole to the diameter and depth for socketed post and end terminal foundations per the manufacturer's specifications. Design the depth based on the project's existing soil boring data; however, the minimum diameter shall be 14 inches and the minimum depth shall be 48 inches. If over excavation is unavoidable, use extra concrete to completely fill the excavation. Otherwise, form, cast and backfill the foundations per Section 207. Dispose of excess excavated material. Install reinforcing steel in accordance with the manufacturer's specifications. Place the concrete and install sockets, ensuring that the top of the foundation is flush with the final grade. Install line posts and fitting gasket. Posts shall be of the type specified, spaced in accordance with the manufacturer's details and specifications. Set posts plumb and in line to provide acceptable line of sight. Take extreme care to ensure proper wire rope height is obtained.

Install cables in accordance with the manufacturer's details and specifications. Position all rigging screws so that there is no interference with posts or other rigging screws unless recommended by the manufacturer. Upon installation, tension each cable in accordance with the manufacturer's specifications. Use certified, calibrated testing equipment specified by the manufacturer at the beginning of the installation and throughout the project. Results from only one model of tension testing device will be accepted. Provide a calibration certificate to the Engineer indicating calibration of the instrument no more than 30 days prior to its first use on the project. Furnish a letter from the manufacturer certifying the person testing is trained and authorized by the manufacturer to perform tension tests on the system. Retest the tension 14 to 21 Days after the initial testing in accordance with the manufacturer's specifications. Re-tensioning will be required when the test reading is less than the manufacturer's recommended tension for the given temperature. Re-tension the cables by successively reading tension measurements at every rigging screw or turnbuckle on each cable being adjusted to the manufacturer's specifications. Repeat the testing and re-tension the cable as necessary until the manufacturer certifies that the full cable system has been installed and tensioned in accordance with the manufacturer's specifications. Any end terminal movement exceeding one inch (1") within 12 months of completed installation that results in a tension reduction to the cable system shall require repair and re-tensioning of the system by the Contractor at no expense to the Department, as directed by the Engineer. Complete a tension log showing the project name, date, time, location, weather conditions, ambient temperature, cable temperature, tension measurement location, actual tension reading, tension reading after adjustment (if necessary), any applicable notes and the signature of the person conducting the test. Furnish a copy of this log to the Engineer along with a letter from the manufacturer certifying that the cable has been tensioned in accordance with their specifications and complies with the manufacturer's tension requirements.

Maintain the cable barrier system during construction until final acceptance of the project. Should the cable barrier be damaged by the traveling public during construction, notify the Engineer immediately. Mark the affected area as directed by the Engineer within eight (8) hours of the initial damage. If only line posts are damaged, replace the posts and re-install the cable to the posts within 48-hours of Contractor notification. If an end terminal is struck and the cables disengaged, the system must be repaired, re-tensioned and tested within 24-hours of Contractor notification. After each hit, the system shall be re-tensioned if required, in accordance with the manufacturer's specifications. If the cable barrier system is damaged by the traveling public during construction, the Contractor will be paid for the repair at the unit bid price for the respective pay items. If the cable barrier is damaged by the Contractor, the barrier system will be repaired at the Contractor's expense.

722.04 Method of Measurement. The quantity of high-tension cable barrier will be measured as the number of linear feet (linear meters) constructed, tested and accepted. The length will be measured from the first line post adjacent to each end terminal for the run of cable barrier. The linear foot quantity shall not include any posts associated with the end terminal, as identified in the manufacturer's shop drawings.

The quantity of end terminals will be measured as the actual number of each end terminal constructed, tested and accepted.

722.05 Basis of Payment. The quantity of high-tension cable barrier will be paid at the Contract unit price per linear foot. Price and payment will constitute full compensation for all labor, materials, equipment, tools, training and incidentals necessary to furnish and install each item of work complete in place, tested and accepted, including but not limited to, excavation, concrete and backfill; installation of all posts, wire rope, reflective sheeting; testing and re-tensioning the high-tension cable barrier system; a tension meter kit; spare line posts, accessories; repair tool rope spreader and other specialized tools necessary to maintain the system; and all related work as shown, specified or directed.

The quantity of end terminals will be paid for at the Contractor unit price per Each. Price and payment will constitute full compensation for all labor, materials, equipment, tools, training and incidentals necessary to furnish and install each item of work complete in place, tested and accepted, including but not limited to, excavation, concrete and backfill; installation of all posts, end terminals, spare end terminal posts and accessories; and all related work as shown, specified or directed.

ITEM	DESCRIPTION	UNIT
722001	HIGH TENSION CABLE BARRIER	LF
722002	HIGH TENSION CABLE BARRIER END TERMINAL	EA

SECTION 723 – CONCRETE BARRIER

723.01 Description. Construct and place Portland Cement Concrete Barrier in accordance with the Contract Documents and as directed by the Engineer.

723.02 Materials. Provide Materials as specified in:

A. Portland Cement Concrete — Section 1022

1. Minimum 28-day compressive strength is 4,500 pounds per square inch
2. Blend of a minimum of 40% slag (GGBFS)
3. Fine aggregate shall be white sand from a source approved by the Engineer

B. Reinforcing Steel — Section 1037

1. Epoxy coated
2. Grade 60

C. Steel Connector Plate — Standard Construction Details

D. Barrier Reflectors — Section 1073

No changes or substitutions of suppliers will be permitted without approval of the Engineer once the Project commences.

723.03 Construction. Provide precast or cast-in place barriers meeting Contract requirements. Slip-form construction methods are only permitted if indicated in the Contract Documents. Conduct a pre-pour meeting at least ten (10) Calendar Days prior to Work with representatives from the Engineer, Contractor, and other interested parties in attendance.

Excavate to the required depth and compact the barrier foundation to the specified density, line and grade. Replace soft and unsuitable material and compact with an approved Material.

After placing the barrier, backfill remaining excavated areas and compact to specified density with approved Material in layers up to 8-inches.

Construct cast-in-place barrier with forms that meet Section 610. Construct precast units as specified in Section 612. Remove the precast units from the forms and casting bed after 12 hours if the units reach a compressive strength of at least 1,400 pounds per square inch. Saw cut joint to ensure crack-free concrete. Any cracking will be repaired at no additional cost to the Department.

Apply a Class 2 rubbed finish as specified in Section 610 to exposed cast-in-place or precast barrier faces.

Ensure that the surfaces of barriers vary no more than 1/4 inch in 10 feet as measured from a straightedge in a longitudinal direction. Meet a tolerance of 1/4 inch in vertical and horizontal alignment between adjoining units measured from a 10 foot straightedge in a longitudinal direction across the joint.

Cast a slot for connecting precast barriers as shown in the Standard Construction Details.

Install barrier reflectors on the face of the traffic side face of the barrier wall sections. Install barrier reflectors as follows:

A. For barrier that is 42 inches tall or taller, install the reflector at a point 39 inches above the final grade of the roadway surface, measured to the top of the reflector.

B. For barrier that is less than 32 inches tall, install the reflector at a point 29 inches above the final grade of the roadway surface, measured to the top of the reflector.

C. Space reflectors horizontally 100 feet apart on center. For sections of barrier wall that are less than 200 linear feet, evenly space a minimum of two reflectors on the traffic face of the barrier wall.

723.04 Method of Measurement. The quantity of concrete barrier will be measured as the number of linear feet constructed and accepted. The length will be measured along the centerline of the concrete barrier.

723.05 Basis of Payment. The quantity of concrete barrier will be paid at the Contract Unit Price per linear foot constructed, complete-in-place and accepted. Price and payment will constitute full compensation for Portland Cement Concrete, excavation, forms, backfill, and installation of barrier reflectors and for all labor, Materials, Equipment, tools, and incidentals necessary to complete the Work, complete in place, and accepted.

Payment for furnishing barrier reflectors will be made under Section 824. Payment for undercut will be made under Section 202.

ITEM	DESCRIPTION	UNIT
723001	P.C.C. SAFETY BARRIER, PERMANENT, SINGLE FACE, 32”	LF
723002	P.C.C. SAFETY BARRIER, PERMANENT, DOUBLE FACE, 32”	LF
723003	P.C.C. SAFETY BARRIER, PERMANENT, SINGLE FACE, 42”	LF
723004	P.C.C. SAFETY BARRIER, PERMANENT, DOUBLE FACE, 42”	LF
723005	P.C.C. SAFETY BARRIER, PERMANENT, DOUBLE FACE, BIFURCATED	LF

SECTION 724 – IMPACT ATTENUATOR

724.01 Description. Furnish and install impact attenuators in accordance with the Contract Documents and as directed by the Engineer.

724.02 Materials. Furnish impact attenuators that have been tested in conformance with and meet the requirements of NCHRP Report 350 or MASH for the location depicted on the Plans and design speed of the roadway. Use the most recent report available at the time of Advertisement. Submit, for approval, manufacturer's certification, manufacturer's installation instructions and FHWA acceptance letter(s) for the impact attenuator prior to installation.

Furnish an impact attenuator that is designed and constructed so there is no solid debris on the roadway after a head-on or side angle impact. Dimensional requirements, if any, shall be as noted on the Plans.

Impact attenuator designs shall be as follows:

A. Type 1 – Test Level 2 - Sacrificial

B. Type 2 – Test Level 2 - Reusable

C. Type 3 – Test Level 2 – Low Maintenance

D. Type 4 – Test Level 3 – Sacrificial

E. Type 5 – Test Level 3 – Reusable

F. Type 6 – Test Level 3 – Low Maintenance

724.03 Construction. Install the impact attenuator using personnel certified by the manufacturer to install such impact attenuators. Submit copies of personnel certification to the Engineer for approval prior to beginning installation. Assemble and install the impact attenuator as specified by the manufacturer. Grade the area between the edge of pavement and the back of the impact attenuator in accordance with the manufacturer's requirements. Provide written certification to the Engineer that the impact attenuator has been properly installed.

When the impact attenuator has been completely installed, notify the Engineer and request acceptance. The Engineer will inspect the installation. Correct any deficiencies noted to the satisfaction of the Engineer. Once the corrective Work is completed to the satisfaction of the Engineer, the installation will be accepted and the Contractor will be relieved from the responsibility for this Item. If this Item is damaged before the Final Acceptance of the Project and the damage is not the result of the Contractor's negligence, the Engineer will notify the Contractor to make repairs, and the Contractor will make repairs at the Unit Bid Price (in the case of complete replacement) or at a negotiated price (in the case of partial replacement or repair). Damage caused by the Contractor shall be repaired at no cost to the Department.

724.04 Method of Measurement. Measure the quantity of impact attenuators as the actual number of impact attenuators furnished assembled, installed, complete-in-place and accepted.

724.05 Basis of Payment. The quantity of impact attenuators will be paid at the Contract Unit Price as specified below. Price and payment will constitute full compensation for all Materials and hardware required for furnishing and installing the impact attenuator complete-in-place and accepted, certificate of compliance from the manufacturer, shop drawings, excavation, foundation (if required) and for all labor, tools, Equipment and incidentals necessary to complete the Work.

ITEM	DESCRIPTION	UNIT
724001	PERMANENT IMPACT ATTENUATOR, TYPE 1	EA
724002	PERMANENT IMPACT ATTENUATOR, TYPE 2	EA
724003	PERMANENT IMPACT ATTENUATOR, TYPE 3	EA
724004	PERMANENT IMPACT ATTENUATOR, TYPE 4	EA
724005	PERMANENT IMPACT ATTENUATOR, TYPE 5	EA

ITEM	DESCRIPTION	UNIT
724006	PERMANENT IMPACT ATTENUATOR, TYPE 6	EA
724007	BULLNOSE END TREATMENT	EA

SECTION 727 – FENCE

727.01 Description. Furnish and erect, repair, or relocate fence and/or gate(s) in accordance with the Contract Documents and as directed by the Engineer.

727.02 Materials. Provide Materials as specified in the follow:

Portland Cement Concrete, Class B	Section 1022
Grout	Section 1047
Fence Materials	Section 1061

727.03 Construction.

727.03.1 Working Drawings

A. Prior to fabrication, submit Working Drawings in accordance with Section 105.04 for all metal Structures with an open span length greater than 60 inches. Working Drawings must include Manufacturer's installation instructions, details, and calculations and, if required by the Engineer, must be sealed by a Professional Engineer Registered in the State of Delaware.

727.03.2 Preparation

A. Remove any trees, brush, fence, or any other obstruction in accordance with Section 201 or 211 prior to installation.

B. Grade fence line and around gate as necessary along fence line to provide proper grade and slope.

727.03.3 Footings

A. Excavate for footings as shown in the Contract Documents.

1. If rock is encountered at a depth less than the planned concrete footing depth, drill a 12 inch deep hole into the rock. The hole must be 2 inches bigger than the largest dimension of the post cross-section.

2. Fill the remainder of the hole around post with grout after post has been set.

B. Place post plumb in center of the footing.

C. Place Portland Cement Concrete, Class B in hole around post. Thoroughly compact concrete around post by tamping or vibrating. Ensure top of footing is slightly above the ground line, finished smooth, and sloped away from the post.

D. Do not place attachments to posts or disturb posts in any way for 72 hours after concrete footing is placed. Do not use hand-mixed concrete unless approved by the Engineer.

727.03.4 Chain Link Fence

A. Applies to both vinyl-coated and non-vinyl-coated chain link fences.

B. Place posts for chain link fence plumb and at 10 foot centers with a tolerance of +0 and -2 feet. Post spacing must be as uniform as practicable. Place post a minimum of 2 foot - 6 inches into the footing.

C. Install terminal posts at all abrupt changes in grade, at changes in line direction over 15 degrees, and at all ends. In no case is the distance between terminal posts to exceed 500 feet.

D. Place top rail through intermediate post tops to form a continuous brace from end to end of each stretch of fence. Fasten top rail to terminal post using heavy pressed steel connectors.

E. Place couplings every 20 feet to join top rail segments. Use couplings that allow for expansion and contraction. Expansion devices must be approved by the Engineer.

F. Install horizontal brace rails with diagonal truss rods and turnbuckles at all terminal posts. Apply sufficient braces to allow complete bracing from each terminal post to adjacent line posts. Install roll formed rail and brace 2 foot apart and the tubular rail and brace 2 foot – 6 inches apart. Extend the rail and brace from the

terminal post to the first adjacent line post. Fasten the braces to the posts by heavy pressed steel connections then trussed from the line posts back to the terminal post with round rods as shown in the Contract Documents.

G. Equip posts with extension arms when barbed wire is required. Extend the arms at a 45 degree angle. Securely fasten the barbed wire using lock-wires equally spaced along the extension arm. Locate the top strand 12 inches above the fabric and 12 inches out from the fence line. Utilize extension arms capable of supporting a dead load of 200 pound at the top strand attachment point without permanently deforming.

H. Install fence fabric on the roadway side of the posts, true to line, taut, and in compliance with the best practice for fence construction. Provide a nominal distance of 3 inches above the ground. Over irregular ground, provide a gap with a minimum of 1 inch and a maximum of 6 inches. Excavate or backfill as necessary to maintain the required gap.

1. At locations where it is not practical to maintain the gap requirements, such as small drainage swales or ditches, span the opening below the fence using wire mesh.

I. Use chain-link bands to secure tension wire to fence posts. Attach the wire to the fence fabric using hog rings spaced at approximately 24 inches on center as shown in the Contract Documents.

J. Attach fence fabric to the line posts using 6 gage wire clips spaced approximately 14 inches apart and to the top rail using 9 gage tie wires spaced approximately 24 inches apart. Ensure end connectors are as close to the ends of the fabric as possible.

K. Securely fasten the fence fabric to all terminal posts using 3/16 inch x 3/4 inch tension bars and 11 gage pressed bands spaced approximately 14 inches apart, or the fabric may be woven integrally into lock loops on roll form sections.

L. When tying into an existing fence, permanently attach the existing fence to terminal posts of the new fence where indicated on the Plans.

M. Install electrical grounds at intervals of no more than 2000 feet and directly below locations where an electrical line passes over the fence. Use a copper clad rod 8 foot long and a minimum 5/8 inch in diameter. Drive the rod vertically into the ground until the top is approximately 6 inches below the soil surface. Clamp a No. 6 solid copper conductor to the road and to the fence in such a manner that each element of the fence is grounded.

N. When using a fence with a coating, properly repair damaged coating in accordance with manufacturer's recommendation.

O. Gates

1. Vehicular Gates

i. Install the fabric to match the fence in the frame by means of tension bars and hook bolts. Equip each frame with 3/8 inch diameter adjustable truss rods. Bottom hinges must be ball and socket type, designed to carry the weight of the gate on the post footing. The upper hinge must be a wrap-around adjustable type.

ii. Equip all gates 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. Ensure vehicular gates are capable of being operated by one person and swing open 180 degrees.

iii. The bottom of vehicular gates must be 3 to 5 inches above the ground when closed and be at least 3 inches above ground at all points of swing. Modify the existing grade within the area of the swing, if necessary, to meet this requirement, or as directed by the Engineer.

iv. Refer to the Standard Construction Details for additional information not included herein.

2. Walk Gates.

    a. Walk gates must be 4 foot in width. The walk gate height must match the fence height as shown in the Contract Documents.

    b. Equip the walk gates with approved latches, stops, locking devices, and approved devices to allow for padlocking.

    c. Refer to Section 727.03.4.O.1.iii for dimensions from bottom of gate to the ground.

727.03.5 Bridge Safety Fence

1. Construct Bridge Safety Fence in accordance with Section 727.03.4 and the Bridge Safety Fence Details in the Contract Documents.

2. Make all longitudinal rails parallel to the top of parapet. Set all posts normal to the top of parapet for roadway grades 6 percent or less; and for grades over 6 percent set the posts plumb.

3. Ensure the chain link fence is true to line, taut and complies with the best practice for fence construction of this type. Permanently position the parts and rails before fabric is placed. Repair or replace any defects uncovered during the process of inspection of welds on base plates and/or poles and/or elsewhere at the sole expense of the Contractor.

727.03.6 Right-of-Way Fence.

A. Place metal posts for right-of-way fence plumb and at 14 foot centers or otherwise as specified on the Plans. Place post a minimum of 2 foot – 6 inches into footing.

B. Firmly attach metal post braces to metal end posts, intermediate end posts, corner posts, and gate posts. Set metal posts and braces in concrete footings as shown in the Contract Documents.

i. Provide corner posts and intermediate end posts with two braces, one each way from the post in the main line of the fence.

ii. Provide end posts and gate posts with one brace in the line of the fence.

iii. Provide line posts with bracing in both directions at intervals of not more than 500 feet.

C. Install fence fabric in accordance with the Contract Documents.

D. Refer to Sections 727.03.4.H through 727.03.4.L for further guidance on installation of the fence.

E. Refer to Section 727.03.4.M. for further guidance on installing electrical grounds.

F. Gates

i. Vehicular gates

    a. Equip the vehicular gates 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 must be of the type shown in the Contract Documents or an alternative as approved by the Engineer and be set in concrete as shown on the Standard Construction Details. Hinges must be of the pivot type, heavy duty, with large bearing surfaces. Clamp hinges onto posts and must not twist or turn under the action of gates. Configure the hinges such that closed gates cannot be lifted off their hinges. Ensure vehicular gates are capable of being operated by one person and swing open 180 degrees.

    b. Refer to Section 727.03.4.O.1.iii.for dimensions from bottom of gate to the ground.

ii. Walk gates

    a. Refer to Section 727.03.4.O

727.03.7 Post and Rail Fence

A. Construct the post and rail fence in accordance with the Contract Documents. Follow the manufacturer's installation instructions. The fence Material may be either wood or vinyl, refer to Section 1061 for further guidance.

B. If gates are specified on the Plans, comply with the manufacturer's installation instructions. Payment for gates will be incidental to the fence Item.

727.03.8 Vertical Slat Fence

A. Construct the post and rail fence in accordance with the Contract Documents and the manufacturer's installation instructions.

B. Install the fence true to line, as indicated, and ensure grade and the top elevation are uniform. Place the vertical boards on the roadway side of posts and backers and maintain a nominal 3 inches above the ground line unless shown otherwise in the Plans. If any grading is required to meet the 3 inches above the ground criteria as stated above or details shown in the Plans, the cost for such Work is incidental to the respective Items. Install the vertical boards of the fence prior to cutting or shaping the top as shown in the Plans.

C. If gates are specified on the Plans, comply with the manufacturer's installation instructions. Payment for gates will be incidental to the fence Item.

727.03.9 Decorative Fence

A. Construct the decorative fence in accordance with the Contract Documents and the manufacturer's installation instructions.

B. Center and align posts, temporarily securing them in place with bracing. Place non-shrink grout around posts. Ensure proper consolidation of the non-shrink grout takes place. Recheck vertical and top alignment of posts, and make necessary corrections.

C. If aluminum fencing is specified, center and align post base plates and anchor on concrete foundations with a neoprene pad, or approved equivalent, at the interface between the aluminum base plate and concrete surface.

D. If gates are specified on the Plans, comply with the manufacturer's installation instructions. Payment for gates will be incidental to the fence Item.

727.03.10 Temporary Construction Safety Fence

A. Space posts no more than 10 feet. Alternate spacing may be approved only if specified by the construction safety fence manufacturer. Concrete footing is not required unless otherwise directed by the Engineer.

B. Use 8 inch self-locking nylon safety ties for securing the fence to the post.

C. Install bottom rail edging for cane detection at least 6 inches above the surface of the sidewalk or pathway, with the bottom of the edging a maximum of 2.5 inches above the surface.

D. Maintain, repair, or replace construction safety fence as necessary when damaged, missing, or worn out.

E. Relocate the safety fence as necessary to perform construction activities.

F. Remove all construction safety fence and associated debris at the direction of the Engineer at the end of construction activities.

G. If gates are specified on the Plans, comply with the manufacturer's installation instructions. Payment for gates will be incidental to the fence Item.

727.03.11 Repair

A. All Materials and construction methods required for repair must conform to the applicable requirements of the Contract Documents.

B. Fence

i. When attaching new fence fabric to the existing fabric or posts, align all posts, fabric and other components properly, including the existing fabric and posts adjacent to the replaced section(s).

ii. Dispose of all damaged fencing and appurtenances, trees, brush, etc. that are removed from the job site by the end of the Working Day they are removed. There will be no separate payment for such Work, and the costs are included in the respective Items.

C. Vehicular Gate

i. When attaching new gates or repairing existing gates, align all posts, gates and other components properly, including the existing fabric and posts adjacent to the repaired or replaced gate(s).

ii. Refer to Section 727.03.11.B.ii for further guidance on disposal of Materials.

727.03.12 Relocate

A. Fence

i. Salvage and reuse all existing fence, posts, hardware and accessories. Any Material which cannot be salvaged, replace with similar Material or approved equal after obtaining approval from the Engineer.

ii. Notify the Engineer and the owner(s) (if applicable) at least three Days in advance prior to removal of the fence, unless otherwise specified in the Contract Documents or by the Engineer. Ensure existing fence, posts, and accessories are removed and salvaged and reset at location indicated on Plan or as directed by the Engineer. Backfill the hole left by the removal of the post with suitable Material.

iii. Spacing and setting of the posts, railing and/or fence panel, must match the existing conditions. Restore all paved or grassed areas disturbed to the original conditions at the Contractor's expense.

B. Vehicular Gate

i. Carefully remove the gate from the existing location and reset at the location designated on the Plans, exercising every precaution to avoid and/or minimize damage to the gate. Safely store the gate, if necessary, until it can be reset. If, in the opinion of the Engineer, damage to the gate was caused due to the negligence of the Contractor, the Contractor will make the repairs to the gate at his own expense to the satisfaction of the Engineer.

ii. Clean the gate posts of any existing debris including existing foundation concrete. If in the opinion of the Engineer the existing posts are not satisfactorily cleaned, the Engineer may request that the Contractor supply new posts, at no additional cost to the Department. The size, type and length must match the existing posts. Set the posts plumb, true to the line and grade shown on the Plans. Embed each gate post in a concrete footing with the minimum dimensions as specified in Section 727.03.3.

727.04 Method of Measurement.

A. The quantity of fence will be measured as the actual number of linear feet along the line of the fence from end to end for each type of fence placed and accepted.

B. The quantity of bridge safety fence will be measured as the actual number of linear feet along the line of the fence from end to end. Any anti-climb shields or other appurtenances will not be measured for payment but be included in the linear feet cost of the bridge safety fence.

C. The quantity of gates will be measured as the actual number of each type of gate installed and accepted.

D. The quantity of fence or gate repair will not be measured.

E. The quantity of relocating fence will be measured as the actual number of linear feet of each type of fence relocated and accepted measured along the fence. The quantity of relocating gates will be measured as the actual number of each type of gate relocated and accepted.

F. The quantity of relocating gates will be measured as the actual number of each type of gate relocated and accepted.

727.05 Basis of Payment.

A. The quantity of fence, bridge safety fence, and relocating fence will be paid for at the Contract Unit Price per linear foot for each type of fence. Price and payment will constitute full compensation for clearing and grading the line of fence; for excavating and backfilling for footings; for furnishing and placing the concrete for footings; for furnishing and erecting fence; for furnishing and installing all Materials including posts, anti-climb shields, fittings, hardware, and grounds; and for all Equipment, labor, tools, and incidentals required to complete the Work. Price and payment for construction safety fence will also include removal and disposal of fence when no longer required and maintenance and/or replacement during construction.

B. The quantity of gates and relocating gates will be paid for at the Contract Unit Price per each for each type of gate. Price and payment will constitute full compensation for clearing and grading the line of gate; for excavating and backfilling for footings; for furnishing and placing the concrete for footings; for furnishing and erecting gate; for furnishing and installing all Materials including posts, fittings, hardware, and grounds; and for all Equipment, labor, tools, and incidentals required to complete the Work.

C. Repairing fence and repairing gates will be paid for at the Contract lump sum price. Price and payment will constitute full compensation for clearing and grading; for excavating and backfilling for footings; for furnishing and placing the concrete for footings; for removal and disposal of existing Materials not to be reused; for furnishing and installing all Materials including posts, fittings, hardware, grounds, hinges, and latches; and for all Equipment, labor, tools, and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
727000	CHAIN LINK FENCE	LF
727001	RIGHT-OF-WAY FENCE	LF
727002	WOOD POST AND RAIL FENCE	LF
727003	VINYL POST AND RAIL FENCE	LF
727004	WOOD VERTICAL SLAT FENCE	LF
727005	DECORATIVE FENCE	LF
727006	TEMPORARY CONSTRUCTION FENCE	LF
727010	CHAIN LINK FENCE GATE	EA
727011	RIGHT-OF-WAY FENCE GATE	EA
727020	FENCE REPAIR	LS
727021	GATE REPAIR	LS
727030	FENCE RELOCATION	LF
727031	GATE RELOCATION	EA

SECTION 760 – PAVEMENT MILLING AND RUMBLE STRIPS

760.01 Description. Mill or plane bituminous concrete and Portland cement concrete pavement in accordance with the Contract Documents. Cut rumble strips in bituminous concrete pavement or Portland Cement Concrete (P.C.C.) pavement in accordance with the Contract Documents and as directed by the Engineer.

760.02 Materials. Not applicable.

760.03 Construction.

760.03.1 Pavement Milling. Use a pavement milling machine suitable for use on bituminous concrete pavement or P.C.C. pavement. Equip machine with guides to provide uniformity and consistency in alignment of each cut with no tearing, snagging or gouging of the resulting surface. Remove any imperfections exceeding 5/16 inch at any point along the surface. Opening a milled surface to traffic, provided it is approved by the Engineer, is only permitted once all loose material is removed from the surface and temporary bituminous concrete wedges are provided at any abrupt grade change, 2 inches or greater, specifically at manholes, drainage inlets, utilities, and egress point.

Taper cuts consist of one pass with a specified depth at one edge and 0 depth at the other edge and will be measured and paid for separately.

An entrance, driveway and intersecting street pavement surcharge (as a separate pay item) will only be considered for areas adjacent to the roadway milling that cannot be completed as part of the mainline or auxiliary operations, as determined by the Engineer. Any intersecting street milling, measured along the centerline, that is 300 linear feet or greater will not be paid as a surcharge.

760.03.2 Rumble Strips. Cut the rumble strips to the dimensions provided in the Contract Documents without tearing or snagging.

Reuse or otherwise dispose of millings in accordance with the Contract Documents. Wasting millings over the shoulder's edge will not be permitted.

760.04 Method of Measurement. The quantity of pavement milling will be measured as the number of square yards per inch of depth or as the number of square yards as indicated on the Contract Documents. Additional depth, not approved by the Engineer in writing, will not be measured.

The quantity of taper cut will be measured in square yards per inch, with the depth determined by the average depth of removal.

The entrance, driveway and intersecting street pavement milling surcharge will be measured as the actual number of square yards of milling performed and accepted.

The quantity of rumble strips will be measured longitudinally as the actual number of linear feet acceptably installed. The twelve foot openings in bike-friendly rumble strips will not be measured for payment.

760.05 Basis of Payment. Pavement milling will be paid for at the Contract Unit Price per square yard per inch, or at the Contract Unit Price per square yard. Price and payment will constitute full compensation for milling or planning the pavement; for the cleanup of the bituminous concrete or PCC pavement residue wedge left from the milling operation including but not limited to along the curb line, adjacent to speed humps, across intersecting street, around manholes, and at the beginning and ending points of the milling operation, for removing and disposing of the milled material; and for all labor, tools, Equipment, and incidentals to complete the Work.

The quantity of Entrance, Driveway, and Intersecting Street milling surcharge will be paid at for at the Contract Unit Price per square yard. Price and payment will constitute full compensation for milling, additional labor and equipment costs involved with the reduced production cause by the Work, for removing and disposing of the milled material; and for all labor, tools, Equipment, and incidentals to complete the Work.

Rumble strips will be paid for at the Contract Unit Price per linear feet, and accepted in-place. Price and payment will constitute full compensation for all labor, tools, Equipment, disposal of waste Material and necessary incidentals to complete the Work.

ITEM	DESCRIPTION	UNIT
760001	RUMBLE STRIPS, FULL LANE WIDTH	LF
760002	BIKE-FRIENDLY RUMBLE STRIPS, BITUMINOUS PAVEMENT	LF
760003	BIKE-FRIENDLY RUMBLE STRIPS, CONCRETE	LF
760004	RUMBLE STRIPS, BITUMINOUS PAVEMENT, SHALLOW DEPTH	LF
760005	RUMBLE STRIPS, CONCRETE, SHALLOW DEPTH	LF
760006	RUMBLE STRIPS, BITUMINOUS PAVEMENT	LF
760007	RUMBLE STRIPS, CONCRETE	LF
760008	RUMBLE STRIPS, CENTER LINE, BITUMINOUS PAVEMENT	LF
760009	RUMBLE STRIPS, CENTER LINE, CONCRETE	LF
760010	PAVEMENT MILLING, BITUMINOUS CONCRETE PAVEMENT	SY-IN
760011	PAVEMENT MILLING, BITUMINOUS CONCRETE PAVEMENT, TAPER CUT	SY-IN
760012	PAVEMENT MILLING, BITUMINOUS CONCRETE PAVEMENT, VARIABLE DEPTH	SY-IN
760013	PAVEMENT MILLING, PORTLAND CEMENT CONCRETE PAVEMENT	SY-IN

SECTION 762 – SAW CUTTING AND BUTT JOINTS

762.01 Description. Mechanically saw cut patch edges or tie-in joints into existing pavement. Construct butt joints by saw cutting and removing the existing bituminous concrete or Portland cement concrete pavement to provide an area to butt the new bituminous concrete pavement against the existing pavement in accordance with the Contract Documents and as directed by the Engineer.

762.02 Materials. Provide Materials as specified in:

Joint Sealant	Section 1042

762.03 Construction Methods.

A. Use a suitable walk behind, motor driven, wet type diamond blade, circular cutter with control devices, mounted on a sturdy frame designed to cut Portland cement concrete and hot-laid, bituminous concrete pavements.

B. Cut a groove in a straight line to sufficient depth to produce an even, neat joint to allow for removal of Material without damage to adjacent pavement.

1. Continuously supply water to the cutting blade either by water tank on the Equipment or by other means.

2. Saw cut the full depth of the pavement.

C. Other Equipment may be used for saw cutting hot-laid bituminous concrete.

D. Continuously remove waste Material, created by saw cutting and pavement removed in order to construct the butt joint, in accordance with Sections 106.08 and 903.03. Seal saw cuts made beyond the limits defined in the Contract Documents with an approved sealant.

762.04 Method of Measurement. The quantity of saw cutting Portland cement concrete and hot-laid bituminous concrete will be measured as the actual number of linear feet of pavement saw cut and accepted, measured along the cut, end to end.

Should composite pavement box exceed 18 inches in depth, the quantity of a second saw cut will be measured as the actual number of linear feet of pavement saw cut and accepted, measured along the second saw cut, end to end.

Overcuts, saw cutting of bituminous concrete shoulders, additional saw cuts resulting from damage caused during patch removal, relief cuts internal to the patch to assist in pavement removal, and transverse saw cuts for crack control (except for the two end joints at the patch perimeter) in Type B patches will not be measured for payment.

The quantity of butt joints will be measured as the number of square yards on the surface of the pavement as defined in the Contract Documents.

762.05 Basis of Payment. The quantity of saw cutting Portland cement concrete and hot-laid bituminous concrete will be paid for at the Contract Unit Price per linear foot. Price and payment will constitute full compensation for saw cutting Portland cement concrete and hot-laid bituminous concrete, disposing of waste Material in compliance with Section 106.08, for sealing overcuts, and for furnishing all Materials, labor, Equipment, tools, and incidentals required to complete the Work.

The quantity of butt joints will be paid for at the Contract Unit Price per square yard. 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.

ITEM	DESCRIPTION	UNIT
762000	SAWCUTTING, BITUMINOUS CONCRETE	LF
762001	SAWCUTTING, CONCRETE, FULL DEPTH	LF
762002	SAWCUTTING, CONCRETE, VARIABLE DEPTH	LF

ITEM	DESCRIPTION	UNIT
762003	SAWCUTTING, GREATER THAN 18” IN DEPTH	LF
762004	BUTT JOINTS	SY

SECTION 763 – INITIAL EXPENSE / DE-MOBILIZATION

763.01 Description. Perform 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 law or regulation, and all other Work and operations that must be performed prior to beginning compensable Items of Work on the Project. Obtain the required insurance and bonds, and all other Items required for the start of Work.

Perform all operations necessary for the final cleanup of the jobsite, for de-mobilization of all personnel and Equipment, and for all paperwork necessary to close out the Project, including, but not limited to, obtaining releases from Subcontractors.

763.02 Materials. Assume responsibility for the adequacy of all Materials that are required to assemble and set up the Project that are not to be a part of the completed Work.

763.03 Construction. Perform all Work in a safe and workmanlike manner.

763.04 Method of Measurement. This Item will not be measured.

763.05 Basis of Payment. Payment will be made at the lump sum Unit Bid Price for "Initial Expense / De-Mobilization", for which price and payment constitutes full compensation for all Work associated with mobilizing and demobilizing the Project as described above and for furnishing all Materials, labor, Equipment and incidentals required to complete the Work.

When the lump sum price for this Item is less than or equal to 5 percent of the Total Bid Price of the entire Contract at the time of Award ("Total Bid Price"), 45 percent of the Item will be paid on each of the first two monthly estimates and 10 percent of the Item will be paid on the final estimate. When the lump sum price for this Item exceeds 5 percent of the Total Bid Price, 2.25 percent of the Total Bid Price will be paid on each of the first two monthly estimates; and that portion exceeding 5 percent of the Total Bid Price, plus the remaining 1/2 percent of the Total Bid Price, will be paid on the final estimate.

Payment of the Contract lump sum price for Initial Expense/De-Mobilization will not be made more than once, regardless of the number of times that the Contractor must mobilize or demobilize from the site.

ITEM	DESCRIPTION	UNIT
763000	INITIAL EXPENSE / DE-MOBILIZATION	LS

DIVISION 800 - TRAFFIC

SECTION 801 – TEMPORARY TRAFFIC CONTROL - GENERAL

801.01 Description.

Maintain vehicular, bicycle and pedestrian traffic through the Project Work zone in a manner that will reasonably provide the least practicable obstruction to all vehicular, bicycle and pedestrian traffic. Comply with the Delaware (DE) MUTCD for all temporary traffic control (TTC).

801.02 Materials.

Provide only crashworthy temporary traffic control devices in accordance with the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350 or the Manual for Assessing Safety Hardware (MASH) published by the American Association of State Highway and Transportation Officials (AASHTO). Certification of compliance with NCHRP Report 350 and/or MASH is required for Category I through Category III temporary traffic control devices. For Category I devices, the manufacturer or Contractor may self-certify that the devices meet the NCHRP Report 350 and/or MASH criteria. Supply the Federal Highway Administration's NCHRP Report 350 and/or MASH eligibility letter, including all applicable attachments, for each type of device that falls under Category II and III devices. Provide the self-certification and/or the FHWA eligibility letters at the pre-construction meeting.

801.03 Construction.

Place and install temporary traffic control devices at their Project specific locations as required in the Contract Documents and in accordance with Chapter 6 of the DE MUTCD and the manufacturer's installation instructions and recommendations prior to the start of construction by certified personnel, as applicable.

Maintain temporary traffic control devices throughout the duration of the Project. Replace damaged temporary traffic control devices within 24 hours of notification, or as directed by the Engineer.

Maintain temporary traffic control devices in, at a minimum, a "marginal" condition in accordance with the brochure entitled "Quality Guidelines for Temporary Traffic Control Devices", available from the American Traffic Safety Services Association (ATSSA). The Engineer has the authority to reject a temporary traffic control device if it is not at a minimum "marginal" condition.

Temporary traffic control devices are the property of the Contractor unless otherwise indicated in the Contract Documents.

801.03.1 General Temporary Traffic Control / Maintenance of Traffic.

The Contractor is responsible for maintaining a Work zone that is sufficient to protect the travelling public and persons working on the Project. The provisions of this Section do not supersede or release the provisions of Section 107.10, Responsibility for Damage Claims.

A. Implement additional safety measures not expressly required by the Contract and necessary to ensure the safety of all persons.

B. Submit to the Engineer, in writing, justifications for any Contractor proposed changes to the TTC Plan or additions to the TTC Plan included in the Contract Documents;

   1. Prepare a new Temporary Traffic Control Plan ("TTCP") signed and sealed by a Professional Engineer registered in the State of Delaware, in accordance with all applicable DelDOT standards and submit to the Engineer for approval prior to the start of Work at each and every location.

   2. Submit the TTCP a minimum of fourteen (14) Days in advance of starting Work.

   3. Longitudinal dimensions for maintenance of traffic configurations may be adjusted slightly to fit field conditions.

C. Submit requests for approval of proposed changes to the Engineer. Inventory existing signs within the

Contract limits;

1. Maintain signs that must remain in place during the Project as noted in the Contract Documents and/or as directed by the Engineer.
2. Remove any other existing signs and properly store to prevent loss or damage.
3. Replace or reimburse the Department for any lost or damaged signs.

D. Throughout the duration of the Contract within the Project limits, maintain access to:

1. All businesses and residences;
   a. Coordinate any temporary closure of a driveway or entrance for tie-in purposes with the Engineer and the property owner in advance of the closure.
2. All transit stops, unless otherwise directed by the Contract Documents or the Engineer;
   a. Maintain an area for the transit vehicle to allow for safe pick-up and drop-off of passengers;
   b. Provide an accessible path for pedestrians to safely access the transit stop.

E. Conduct construction operations in a manner that will minimize delays to traffic, and meet the following requirements:

1. For Work within intersections and in close proximity to intersections, follow the requirements of the memorandum titled, "Temporary Traffic Control within Intersections", of the DE MUTCD.
2. Schedule Work in the vicinity of traffic signals to minimize the time during which the signal is operated without detectors.
3. When a lane adjacent to an open lane is closed, set temporary traffic control devices on the work zone side of the pavement marking if possible.
4. Do not close lanes unless a construction activity requiring a lane closure is taking place or will take place within one hour, except for "buffer lanes" on high volume and/or high speed roadways. Reopen lanes immediately upon completion of the Work. Shorten the lane closure for moving operations as Work progresses and as traffic conditions warrant to keep the length of the closure to a minimum. Conduct construction operations in a manner that minimize disruption to traffic during peak hours and periods of heavy traffic flow. The Department reserves the right to stop the Contractor's operations if, in the opinion of the Engineer, such operations are unnecessarily impeding traffic.

801.03.2 Notifications to the Engineer.

A. Submit notifications to the Engineer for Road Closures and Detours:

1. No less than fourteen (14) Days prior to the start of any detours and road closures.
2. Obtain approval of Chief Traffic Engineer or designee a minimum of 48 hours in advance of proposed restrictions beyond those specified and approved in the Contract Documents.

B. Loop Detectors at Signalized Intersections:

1. Submit a schedule seven (7) Days in advance of the proposed start date of Work. Obtain Engineer approval prior to the start of Work.
2. Notify the DelDOT Transportation Management Center ("TMC") 48 hours in advance of cutting a loop detector and immediately notify the TMC once the loop detector has been reinstalled.

C. Provide written notice to property owners, businesses, and residents.

1. Provide written notice, 48 hours in advance of the start of construction Work.
   a. Include, at a minimum, the scope of Work, working hours, anticipated start and completion dates and a summary of construction activities that might interfere with access to the property;
   b. Provide a Schedule and access coordination Plan;

c. Provide the Contractor's name and address and a DelDOT contact phone number; and

d. Provide written verification to the Engineer that the property owners and residents were notified.

2. Failure to give proper notice is justification for suspension of Work as specified in Section 104.08 until proper notice is given.

D. Prior to obstructing a fire hydrant:

1. Notify the local 911 center;

2. Provide written confirmation to the Engineer that the local 911 center was notified.

801.03.3 Pavement Edge Drop-offs and Vertical Differences.

A. Correct all pavement edge drop-offs in accordance with the DE MUTCD at the end of each Day.

1. Use Temporary Roadway Material ("TRM") to accomplish this Work unless an alternate method is specified in the Plans.

B. Fill all ruts and potholes with TRM as soon as possible.

C. Place TRM in accordance with the applicable Sections of this Specification.

1. TRM is incidental to the appropriate Item in the Contract.

2. When temporary elimination of a drop-off hazard cannot be accomplished, follow the requirements of Section 6G .20 of the DE MUTCD

a. Properly mark and protect the drop-off hazard with temporary barriers, barricades, warning signs, etc.

D. Steel plates may be used to protect an open trench area accessible by vehicular traffic that cannot be backfilled prior to the end of the Day.

1. Furnish and install steel plates in accordance with the Standard Construction Details.

2. If steel plates are larger than that specified in the Standard Construction Details, submit steel plate shop drawings prepared and signed by a Professional Engineer registered in the State of Delaware for approval prior to the start of construction:

a. Show the intended method to brace, sheet, support or shore the excavation to prevent a trench failure;

b. Show details of the plating design, the method of fastening the plates, plate thickness, span, bearing and the method of preventing the movement of the plates;

c. When steel plates are placed on a travel lane or shoulder, follow the standards presented in Table 6G-1 of the DE MUTCD.

i. Provide a ramp (wedge) around the steel plate using TRM placed at a slope of 20 to 1 or flatter.

3. Steel plates are not permitted between November 1 and April 1, without the prior approval of the Engineer.

801.03.4 Temporary Pavement Markings.

Apply temporary pavement markings to all locations that require permanent pavement markings at the end of each Day's operation and before traffic is returned to unrestricted roadway use.

A. Match temporary pavement markings to permanent pavement markings as shown in the Contract Documents or as directed by the Engineer.

1. Maintain temporary markings in at least the "marginal" condition in accordance with the ATSSA Quality Guidelines.

2. Maintain retroreflectivity levels in accordance with Section 817.

3. Refresh temporary pavement markings as required or as directed by the Engineer.

4. When the temporary markings layout is not provided in the Contract Documents, apply temporary pavement markings in accordance with the requirements of Section 817, the DE MUTCD, and DelDOT's Temporary Pavement Markings Policy of the DE MUTCD.

B. Remove all conflicting pavement markings as directed by the Engineer in accordance with Section 817.

1. Painting over the conflicting pavement markings is not permitted unless specifically stated in the Contract Documents.

C. When pavement marking information is not provided in the Contract Documents, prior to beginning construction:

1. Submit for approval, detailed drawings that depict the existing pavement markings for each Project location.

a. Include all lane and shoulder widths, turn lane lengths, locations of stop bars, turn arrows, crosswalks and railroad crossings;

b. The Engineer may require changes to the final pavement markings.

801.03.5 Travel Lane and Road Closure Restrictions.

Travel lane, turn lane, ramp closures and/or road closures are not permitted during the following Holiday periods, unless otherwise noted in the Contract Documents:

A. December 24 through December 27 (Christmas Day)

B. December 31 through January 3 (New Year's Day)

C. Friday prior to Easter through Easter Sunday

D. Thursday prior to Memorial Day through the Tuesday following Memorial Day

E. July 3 through July 5 (Independence Day)

F. Thursday prior to Labor Day through the Tuesday following Labor Day

G. Wednesday prior to Thanksgiving Day through the Monday following Thanksgiving Day

Additional restrictions may apply as noted in the Contract Documents or as directed by the Engineer.

801.03.6 Non-Compliance.

Failure to comply with the requirements of this Section is justification for suspension of Work as specified in Section 104.08. Time charges will continue to be assessed until all deficiencies are corrected.

A. Non-compliance includes but is not limited to the following:

1. Deficiencies not corrected within 24 hours related to temporary traffic control or temporary traffic control devices reported to the Contractor in writing unless otherwise directed by the Engineer;

2. Non-compliance with the DE MUTCD or the Contract Documents.

3. Unsafe operations

4. Placement of non-compliant temporary traffic control devices

801.04 Method of Measurement.

This Item will not be measured.

801.05 Basis of Payment.

Temporary Traffic Control will be paid for at the lump sum Contract price. Price and payment will constitute full compensation for all maintenance of traffic activities accepted by the Engineer, including submitting Temporary Traffic Control Plans, submitting certifications, use of traffic cones, correcting edge drop-offs, certified ATSSA

Traffic Control Supervisor when required by the Contract Documents, and for all labor, Equipment, tools and incidentals necessary to complete the Item. The cost to move temporary traffic control devices in accordance with the Temporary Traffic Control Plans or as necessary to address safety issues is included in this Item.

If the Contractor does not complete the Contract Work within the allowable Contract time, including approved time extensions, the Contractor is responsible for providing and maintaining the necessary temporary traffic control devices that are required to complete any remaining Work and will not be paid for providing or maintaining the TTC devices per Section 108.08.

The Engineer will not pay the Contractor for temporary traffic control devices that the Contractor installs to perform Work, but then fails to perform that Work.

If steel plates are used, the cost of furnishing and installing steel plates is incidental to the Item being constructed.

ITEM	DESCRIPTION	UNIT
801000	MAINTENANCE OF TRAFFIC	LS

SECTION 802 – ARROW BOARDS

802.01 Description.

Furnish, place, relocate and maintain portable arrow boards in accordance with the Delaware (DE) MUTCD, the Contract Documents and as directed by the Engineer. Arrow boards will remain the property of the Contractor.

802.02 Materials. Not applicable.

802.03 Construction.

Utilize and place arrow boards in accordance to the applicable sections of the DE MUTCD. Trailer to be in accordance with Title 21 Motor Vehicles of the Delaware Code. Maintain arrow boards in good working order such that the arrow board meets, at a minimum, the "marginal" criteria of the brochure entitled "Quality Guidelines for Temporary Traffic Control Devices" as required in Section 801.03. Remove arrow boards from the roadway when no longer in use. Do not store arrow boards along the shoulder or adjacent to the edge of the roadway within the clear zone.

802.03.1 Equipment.

Provide solar powered arrow board with double pointed arrow configuration capable of displaying a left arrow, a right arrow, a double arrow or a four corner caution mode. Do not display a sequential chevron. The back panel of arrow boards must be equipped with three indicator lamps indicating the proper functioning of the board. Provide arrow board types as indicated in the table below:

Arrow Board Type	Minimum Size
A	48 x 24 inches
B	60 x 30 inches
C	96 x 48 inches

802.04 Method of Measurement.

The Engineer will measure arrow boards as the actual number of arrow boards used each Day. A Day consists of any approved usage within 24 hours of placing the device. Each arrow board will be measured only once per 24 hour period, regardless of how many times it is relocated within the same Project. When an arrow panel is used for part of a Day, it will be measured for as one each Day.

802.05 Basis of Payment.

Price and payment constitutes full compensation for furnishing, placing, maintaining and relocating arrow boards at the Contract Unit Price for each arrow board per Day, including the static arrow (W1-6) sign, when applicable, and for all labor, tools, Equipment and necessary incidentals to complete the Work included in the Items listed below.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
802001	ARROW PANELS, TYPE A	EA-DY
802002	ARROW PANELS, TYPE B	EA-DY
802003	ARROW PANELS, TYPE C	EA-DY

SECTION 803 – PORTABLE CHANGEABLE MESSAGE SIGN (PCMS)

803.01 Description.

Furnish, place, operate, relocate and maintain portable changeable message signs ("PCMS") in accordance with the Delaware (DE) MUTCD, the Contract Documents and as directed by the Engineer. PCMS will remain the property of the Contractor.

803.02 Materials. Not applicable.

803.03 Construction.

803.03.1 Equipment.

Provide PCMSs meeting the requirements of the DE MUTCD, consisting of like new, corrosion resistant Materials and the following:

A. Trailer – in accordance with Title 21 Motor Vehicles of the Delaware Code.

B. Sign Panel – not to exceed 144 inch length, 90 inch height, 12 inch depth.

C. Equip with sighting device to determine proper alignment for maximum visibility.

D. Display

1. Capable of displaying three lines of text

   a. Construct each line of text using either a discrete matrix or a full matrix display.

   b. If discrete matrix is used, display each character using a 5 x 7 array with at least eight array modules per line.

   c. Provide a 4-1/4 inch to 7 inch space between each display line with no glare reflection.

2. Capable of displaying eight characters per line

   a. Ensure character height be at least that required by the DE MUTCD.

3. Capable of LED illumination

E. Provide plastic drums, in accordance with Section 805, used to channelize traffic away from the PCMS unless the PCMS is placed behind guardrail, barrier or other means of positive protection. Place plastic drums in accordance with the DE MUTCD.

F. Meet necessary requirements of National Fire Protection Association ("NFPA"), Underwriters Laboratories ("UL"), and National Electrical Code ("NEC").

G. Do not place PCMS on or near bicycle lanes, sidewalks or shared use paths in a manner that restricts the use of these facilities by pedestrians or bicyclists. Provide a minimum 4 foot buffer between the edge of the travel lane and the farthest extent of the PCMS to allow bicycle traffic to pass without encroaching into the travel lane wherever possible.

803.03.2 Operating Requirements.

Ensure that sign messages are visible and legible for the distances noted in the DE MUTCD. Align the PCMS with the sighting device it is equipped with, to provide alignment for maximum visibility.

Use PCMS units in accordance with the DE MUTCD. Place PCMS units at the locations shown in the Contract Documents or as directed by the Engineer. Approval is required from the Engineer prior to placement of the PCMS. If approved messages or locations are not provided in the Contract Documents, submit a *PCMS Approval Form*, to the Engineer for review and approval of messages and the location of the PCMS.

Repair or replace PCMS within 24 hours or less after receipt of notification of an operational problem. Failure to correct the problem within the 24 hours will result in deduction of payment for the Day the unit is not satisfactorily operating and may result in further sanctions.

803.04 Method of Measurement.

The Engineer will measure PCMS units as the actual number of PCMS units used per Day. A Day consists of any approved usage within 24 hours of placing the device. Each PCMS unit will be measured only once per Day, regardless of how many times it is relocated within the Project. When a PCMS unit is used for part of a Day, it will be measured as one each Day.

Plastic drums required by this Section will be measured in accordance with Section 805.

803.05 Basis of Payment.

Price and payment constitutes full compensation for furnishing, placing, operating, maintaining and relocating PCMS units at the Contract Unit Price for each PCMS unit used per Day; and for all labor, tools, Equipment and necessary incidentals to complete the Work included in the Item listed below.

Plastic drums required for channelization around the PCMS will be paid for in accordance with Section 805.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
803001	FURNISH AND MAINTAIN PORTABLE CHANGEABLE MESSAGE SIGN	EA-DY

SECTION 804 – PORTABLE LIGHT ASSEMBLY (FLOOD LIGHTS)

804.01 Description.

Furnish, place, operate, relocate and maintain portable light assemblies in accordance with the Delaware (DE) MUTCD, the Contract Documents and as directed by the Engineer.

804.02 Materials. Not applicable.

804.03 Construction.

Provide a portable light assembly unit that includes four, 1000 Watt lights with a fully self-contained power source mounted to a trailer equipped to be towed by a full-sized pick-up truck and in full compliance with Title 21 Motor Vehicles of the Delaware Code.

Provide plastic drums, in accordance with Section 805, used to channelize traffic away from the portable light assembly unless the portable light assembly is placed behind guardrail, barrier or other means of positive protection. Place plastic drums in accordance with the DE MUTCD.

804.03.1 Operational Requirements.

Place portable light assembly at locations depicted in the Contract Documents and/or as directed by the DE MUTCD. Position the portable light assembly so as not to shine light directly at oncoming traffic. Extend the light assembly vertically to the unit's fullest extent and direct the lights downwards toward the area being lit but not exceeding more than 60 degrees measured off of the ground as to prevent glare. Use channelization devices as required by the DE MUTCD to delineate the portable light assembly.

Repair or replace portable light assembly units within 30 minutes or less after receipt of notification of an operational problem. Failure to correct the problem within the required timeframe will result in deduction of payment for the day the unit is not satisfactorily operating. Designate an on-site representative to be the Department's contact person on all issues related to the portable light assembly. The on-site representative should be the ATSSA Traffic Control Supervisor, as defined in Section 812. If an ATSSA Traffic Control Supervisor is not required by the Contract Documents, then the on-site representative can be the Superintendent or designee. If a portable light assembly that is being used to illuminate a flagger station fails to work, remove the flagger from the roadway and restore the roadway to normal operations until the portable light assembly is replaced unless opening the roadway to normal operations presents a safety hazard to motorists or as otherwise directed by the Engineer.

804.04 Method of Measurement.

The Engineer will measure portable light assembly units as the actual number of portable light assembly units used each Day. Plastic drums required for channelization around portable light assemblies will be measured in accordance with Section 805.

804.05 Basis of Payment.

Price and payment constitutes full compensation for furnishing, placing, operating, maintaining, furnishing fuel and relocating portable light assembly units at the Contract Unit Price for each portable light assembly unit used each Day, and for all labor, tools, Equipment and necessary incidentals to complete the Work included in the Items listed below.

Plastic drums required for channelization around the portable light assemblies will be paid for in accordance with Section 805.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
804001	FURNISH AND MAINTAIN PORTABLE LIGHT ASSEMBLY (FLOOD LIGHTS)	EA-DY

SECTION 805 – PLASTIC DRUMS

805.01 Description.

Furnish, place, relocate and maintain plastic drums in accordance with the Delaware (DE) MUTCD, the Contract Documents and as directed by the Engineer.

805.02 Materials.

A. Provide plastic drums as specified in the DE MUTCD and as specified below.

1. Only drums made of low density polyethylene plastic, orange in color, are permitted.

a. Tops must be closed to prevent collection of debris; however, holes of no more than 1/2 inch are allowed to allow for "breathing" so as not to create an enclosure susceptible to wind.

b. Metal drums are not permitted.

2. Supply manufacturer certification to the Engineer in accordance with Section 801.02.

3. Equip each plastic drum with an approved integral device able to withstand 60 mile per hour winds.

a. Drums may not be weighted with sand bags.

b. At the direction of the Engineer or as noted in the Contract Documents, additional ballast weight may be required on high speed roadways or areas susceptible to high winds. No additional payment will be made for additional ballast.

4. Minimum dimensions are 18 inches in diameter at the top and bottom and 36 inches high.

5. Plastic drums may be either new or meeting the requirements of the "Quality Guidelines for Temporary Traffic Control Devices" as defined in Section 801.

6. Equip each plastic drum with a minimum of two fluorescent orange prismatic retroreflective and two white prismatic retroreflective stripes with the top stripe being fluorescent orange.

7. Plastic drums must meet applicable reflectivity requirements.

B. Retroreflective sheeting for plastic drums per ASTM D4956, Type V.

1. Alternating horizontal circumferential fluorescent orange and white prismatic retroreflective stripes 4 to 6 inches wide.

2. Ensure fluorescent orange sheeting displays similar color under both daylight and nighttime conditions.

3. Nonretroreflectorized spaces between the horizontal fluorescent orange and white strips cannot exceed 3 inches.

805.03 Construction.

A. Place drums as Contract Documents and/or the DE MUTCD dictate.

1. Refer to the applicable sections of the DE MUTCD for additional requirements.

B. Relocate drums as Contract Documents and/or the DE MUTCD dictate.

C. Immediately replace or clean any drum when the drum is damaged, needs cleaning, does not meet the requirements of Section 801.02 or has deteriorated to the extent it is no longer effective.

The Engineer may reject unsuitable plastic drums and will notify the Contractor of their location. The Engineer will not measure or pay for ineffective drums not immediately replaced.

805.04 Method of Measurement.

The Engineer will measure plastic drums as the actual number of plastic drums acceptably furnished, installed and maintained each Day.

805.05 Basis of Payment.

Price and payment constitutes full compensation for furnishing, placing, maintaining, relocating and removing plastic drums at the Contract Unit Price each Day and for all labor, tools, Equipment and necessary incidentals to complete the Work included in the Items listed below.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
805001	PLASTIC DRUMS	EA-DY

SECTION 806 – TRAFFIC OFFICERS

806.01 Description.

Furnish traffic officers as required by the Contract Documents or as directed by the Engineer.

806.02 Materials. Not applicable.

806.03 Construction.

A. Use traffic officers in a highway work zone in accordance with the latest version of DelDOT's "Guidelines for the Use of Uniformed Law Enforcement Officers in Work Zones" of the Delaware (DE) MUTCD.

1. Project specific requirements for the use of traffic officers can be found in maintenance of traffic notes in the Contract Documents.

B. All traffic officers are required to wear police officer uniforms.

C. Traffic officers outside of their vehicle are required to wear high-visibility safety apparel as required in the DE MUTCD.

D. The Engineer may authorize additional officers to be used for speed enforcement.

E. Vehicles are required to be marked police vehicles equipped as follows:

1. Full external light bar that is clearly visible for 360 degrees around the vehicle and at a distance of not less than 3,000 feet under normal atmospheric conditions at night,

2. Radar unit or any other speed-measuring device,

3. Radio communication available to inform 911 and DelDOT's Transportation Management Center (TMC) of traffic backups or other emergencies.

F. The traffic officer can be Town Police, Municipal Police, County Police or Delaware State Police in accordance with the jurisdictional location of the Project and availability of the police officers. When questions of jurisdiction arise, the Delaware State Police will make the determination as to which police agency has jurisdiction.

G. Discuss with the Engineer in advance for approval of the schedule of hours and the number of traffic officers anticipated for each site or operation. Submit the request for the number of traffic officers and anticipated Work schedules on a weekly basis to the police agency having jurisdiction. Submittal schedule will be dictated by the police agency having jurisdiction. Failure to submit requests to the police agency having jurisdiction could result in not having traffic officers for the Work and a potential shut down of the Work operation.

H. It is the responsibility of the Contractor to explain to the officer the Project activities pertaining to where the officer's services are needed and/or what the duties of the officer will be. Explain responsibilities with the Engineer or their designee present.

I. Do not use traffic officers to close lanes without additional temporary traffic control except in emergencies.

J. If the required number of traffic officers is not available for a given operation, the operation may commence only with the approval of the Engineer.

806.04 Method of Measurement.

The Engineer will measure traffic officers as the actual number of hours of traffic officers used.

806.05 Basis of Payment.

Price and payment constitutes full compensation for scheduling, billing and furnishing traffic officers at the Contract Unit Price per hour, for the vehicle, all Equipment, the Contractor's allowable administrative cost, tools, and necessary incidentals to complete the Work included in the Items listed below.

For bidding purposes, the Unit Price is fixed at $75.00 per hour. Actual payment is based on the submitted invoice from the police department plus ten (10) percent.

Payment will be made for accepted quantities at the fixed Unit Price as follows:

ITEM	DESCRIPTION	UNIT
806001	TRAFFIC OFFICERS	HR

SECTION 807 – TEMPORARY SAFETY BARRIER

807.01 Description.

Furnish, install, relocate, maintain and remove temporary safety barrier in temporary traffic control zones in accordance with the Delaware (DE) MUTCD, the Contract Documents and as directed by the Engineer.

807.02 Materials.

807.02.1 Temporary P.C.C. Safety Barrier

A. Furnish crashworthy Temporary P.C.C. Safety Barrier crash tested under the provisions of NCHRP Report 350 or the Manual for Assessing Safety Hardware (MASH), tested at the Test Level 3 criteria.

1. Submit eligibility letters in accordance with Section 801.02.
2. Provide segments of barrier with a stamp molded into the top indicating that the barrier is compliant with NCHRP Report 350 or MASH. For barrier segments with no molded stamp, submit certification to the Engineer that the barrier has been crash tested in accordance with NCHRP Report 350 or MASH and meets Test Level 3 criteria.
3. Provide unpinned barrier system that has tested dynamic deflections of no more than 4 feet.
4. Provide pinned barrier system that has tested dynamic deflections of no more than:
   a. 10 inches when pinned into a bituminous asphalt surface,
   b. 6 inches when anchored into a concrete surface.

807.02.2 Reflector Panels

A. Provide reflector panels meeting the requirements of the DE MUTCD.

B. Sign Material made from 0.080 gauge aluminum.

C. Fluorescent orange prismatic retroreflective sheeting on both sides of aluminum.

807.02.3 Glare Screen

A. Furnish glare screen as required by the Contract Documents.

1. Syro Glarefoil screening as supplied by Syro Steel, SAFE-HIT glare screen, or approved equal.

B. Use galvanized hardware in accordance with manufacturer's recommendations.

807.03 Construction.

807.03.1 Temporary P.C.C. Safety Barrier

A. Prior to transporting temporary P.C.C. safety barrier to job site, arrange a pre-inspection of the barrier segments with the Engineer.

1. Do not transport barrier to the job site that is rejected during the pre-inspection.

B. Prior to installation, paint the traffic side of the barrier with a white latex paint.

C. Installation of unpinned barrier

1. Install unpinned barrier at the locations depicted in the Contract Documents or as directed by the Engineer.
   a. Install unpinned barrier starting at the impact attenuator and working in the direction of traffic flow.
2. Connect unpinned barrier segments using approved joint connections.
   a. Use one type of joint system for a single run of unpinned barrier.

D. Installation of pinned barrier

1. Holes for pin or anchor installations must be integral to the barrier segment.

   a. Metal straps anchored to the toe of the barrier and the pavement are not approved unless part of the crash tested system.

2. Install pinned barrier at the locations depicted in the Contract Documents or as directed by the Engineer.

   a. Install pinned barrier starting at the impact attenuator and working in the direction of traffic flow.

3. Connect barrier segments using approved joint connections.

   a. Use one type of joint system for a single run of pinned barrier.

4. Installation on bituminous surface:

   a. Drive pins at the locations specified by the manufacturer, using pins supplied by the manufacturer and in accordance with manufacturer requirements.

5. Installation on concrete surface:

   a. Install anchors at the locations specified by the manufacturer, using the anchors supplied by the manufacturer and in accordance with manufacturer requirements.

E. Removal of unpinned barrier:

1. Remove barrier segments from the roadway.

   a. Begin removal starting at the downstream end of the barrier run and proceed in the opposite direction of traffic flow towards the impact attenuator.

F. Removal of pinned barrier:

1. Remove barrier segments from the roadway.

   a. Begin removal starting at the downstream end of the barrier run and proceed in the opposite direction of traffic flow towards the impact attenuator.

   b. As pins or anchors are removed, fill the remaining holes in the pavement with approved epoxy material. Cutting of pins or anchors flush with the pavement surface is not permitted.

G. Relocation of Temporary P.C.C. Safety Barrier:

1. Relocate existing runs of temporary P.C.C. safety barrier to the locations depicted in the Contract Documents or as directed by the Engineer.

   a. Remove existing runs of temporary P.C.C. safety barrier in accordance with Section 807.03.1.E. or Section 807.03.1.F., as applicable.

   b. Install barrier at the new location in accordance with Section 807.03.1.C. or Section 807.03.1.D., as applicable.

H. Maintenance of Temporary P.C.C. Safety Barrier:

1. Maintain temporary P.C.C. safety barrier while the barrier is in place.

2. Replace any segments of barrier not meeting the "marginal" criteria of the "Quality Guidelines for Temporary Traffic Control Devices", in accordance with Section 801.03.

   a. Repair of cracks or spalls in temporary P.C.C. safety barrier is not permitted.

3. Replace barrier segments damaged by Equipment or an errant vehicle within 24 hours upon notification of damage.

4. Straighten sections of un-damaged barrier wall that have deflected due to a crash within 24 hours upon notification.

5. Repaint the traffic side of temporary P.C.C. safety barrier once per year as directed by the Engineer, but at a minimum in the spring after snow clearing activities.

807.03.2 Reflector Panels

1. For all types of temporary P.C.C. safety barrier:
   a. Upon completion of barrier installation, install reflector panels using appropriate bolts and/or epoxy.
      i. Install reflector panels at the intervals required by the DE MUTCD.
   b. Upon completion of barrier relocation, replace damaged reflector panels or those reflector panels not meeting at least the "marginal" criteria of the "Quality Guidelines for Temporary Traffic Control Devices", as defined in Section 801.03, within 24 hours of notification.
   c. Prior to removal of temporary P.C.C. safety barrier, remove reflector panels using appropriate methods so as not to damage the barrier.
   d. Replace damaged reflector panels or those reflector panels not meeting at least the "marginal" criteria of the "Quality Guidelines for Temporary Traffic Control Devices", in accordance with Section 801.03, within 24 hours of notification.

807.03.3 Glare Screen

1. Furnish and install glare screen on top of temporary P.C.C. safety barrier only if required in the Contract Documents.
2. Submit shop drawings for the glare screen system to be used showing recommended installation spacing, angle, height and all Materials for approval by the Engineer.
3. Install glare screen in accordance with the recommended practices of the supplier and the details shown on the approved shop drawings.
4. Repair damaged sections of glare screen within 24 hours of notification.
5. When glare screen is no longer required, remove glare screen from the barrier wall using appropriate methods so as not to damage the barrier.

807.04 Method of Measurement.

The Engineer will measure temporary P.C.C. safety barrier as the actual number of linear feet along the centerline of barrier in place, furnished and installed or relocated.

The Engineer will measure reflector panels as the actual number of reflector panels installed, complete-in-place and accepted.

The Engineer will measure glare screen as the actual number of linear feet of glare screen furnished, installed and accepted. The length of the glare screen will be measured along the line of the screen from center to center of the end section.

807.05 Basis of Payment.

A. Temporary P.C.C. Safety Barrier
   1. Furnish and install:
      a. The accepted quantities of temporary P.C.C. safety barrier will be paid for at the Contract Unit Price per linear feet of barrier furnished, installed, complete-in-place and accepted. Price and payment constitutes full compensation for furnishing, installing, painting and maintaining temporary P.C.C. safety barrier, for the setting of pins or anchors in pinned barrier installations, removal of barrier when no longer needed and for all labor, Equipment, tools and incidentals necessary to complete the Work.
      b. Payment for all subsequent relocations after initial placement will be made under Section 807.05.A.2.

2. Relocation

   a. The accepted quantities of temporary P.C.C. safety barrier relocated will be paid for at the Contract Unit Price per linear feet. Price and payment will constitute full compensation for removing barrier from the existing location, sealing holes from pins or anchors as necessary, temporary storage at the job site, furnishing paint and painting, installation at a new location and for all labor, Equipment, tools and incidentals necessary to complete the Work. No additional payment will be made for movement of barrier needed to access work areas.

B. Reflector Panels

1. The accepted quantities of reflector panels will be paid for at the Contract Unit Price per each. Price and payment will constitute full compensation for furnishing, installing, and maintaining reflector panels, replacement of reflector panels damaged by traffic, for subsequent removal and re-installation of reflector panels on relocated temporary P.C.C. safety barrier and for all labor, Equipment, tools and incidentals necessary to complete the Work.

C. Glare Screen

1. The accepted quantities of glare screen will be paid for at the Contract Unit Price per linear feet. Price and payment will constitute full compensation for furnishing, installing, and maintaining glare screen, replacement of glare screen damaged by traffic for removal when no longer needed and for all labor, Equipment, tools and incidentals necessary to complete the Work.

2. Payment will be made for the initial installation on the barrier only and will not be made for any subsequent barrier relocations.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
807001	FURNISH AND INSTALL TEMPORARY PCC SAFETY BARRIER, UNPINNED	LF
807002	FURNISH AND INSTALL TEMPORARY PCC SAFETY BARRIER, PINNED IN BITUMINOUS PAVEMENT	LF
807003	FURNISH AND INSTALL TEMPORARY PCC SAFETY BARRIER, PINNED IN CONCRETE	LF
807004	RELOCATE TEMPORARY PCC SAFETY BARRIER, UNPINNED	LF
807005	RELOCATE TEMPORARY PCC SAFETY BARRIER, PINNED IN BITUMINOUS PAVEMENT	LF
807006	RELOCATE TEMPORARY PCC SAFETY BARRIER, PINNED IN CONCRETE	LF
807007	REFLECTOR PANELS	EA
807008	GLARE SCREEN	LF

SECTION 808 – TRUCK MOUNTED ATTENUATOR (TMA)

808.01 Description.

Furnish, position and maintain truck mounted attenuator(s) (TMA) in accordance with the Delaware (DE) MUTCD, the Contract Documents, and as directed by the Engineer.

808.02 Materials. Not applicable.

808.03 Construction.

A. Position the TMA appropriately for the type of work occurring.

1. Use the TMA as required by the DE MUTCD.
2. Position the TMA such that the manufacturer's recommended roll-ahead distance is provided between the front bumper of the shadow vehicle and the closest point of the Work area.
    a. Maintain a copy of the manufacturer's recommended roll-ahead distance in the shadow vehicle at all times and make available for inspection upon request of the Engineer.
3. Do not block any open driveways, commercial entrances, streets or cause any sight distance restrictions unless approved by the Engineer.
4. Position the TMA in the full down position and set the display for the arrow board to the appropriate designation based upon the type and location of the Work occurring.
5. If a distance exists that is twice the roll ahead distance between what the TMA is protecting and the front of the shadow vehicle, then additional TMAs will be required to protect the Work zone.

808.03.1 Equipment.

A. Furnish a truck (shadow vehicle), driver and truck or trailer mounted attenuator.

1. Shadow vehicle must be in good operating condition.
2. Shadow vehicle must have a valid registration, registration number plate, current inspection documentation, weight verification and proof of insurance.
3. Only operators with a valid driver's license of the required class may operate the shadow vehicle.
4. Attenuator may be of the truck or trailer mounted style meeting the crash testing requirements of NCHRP Report 350 or MASH.
    a. Submit FHWA eligibility letters in accordance with Section 801.02.
    b. Ensure a Type I TMA meets the requirements of Test Level 2 and do not use on roadways with posted speeds greater than 40 miles per hour.
    c. Ensure a Type II TMA meets the requirements of Test Level 3.
5. Attach the TMA to the back of the shadow vehicle in accordance with the manufacturer's recommendations.
6. The weight of the shadow vehicle must be in accordance with the TMA manufacturer's recommendations.
    a. Maintain a weight ticket, in the vehicle at all times, from a certified scale house indicating the weight of the shadow vehicle and have available for inspection upon request by the Engineer.
    b. If a counter weight is installed on the shadow vehicle, it must be secured per Federal Motor Vehicle guidelines so as not to shift when braking or if the TMA is impacted.
7. Cover the entire height and width of the TMA end with 6 inch diagonal inverted "V" stripes of alternating yellow retroreflective and black material placed 6 inches apart.

8. Provide a large rotating amber beacon or strobe lights on the shadow vehicle in such a manner to be compliant with the DE MUTCD.

9. Provide on the TMA a Type C arrow board in accordance with the DE MUTCD and Section 802.

    a. For proper acceptance, the TMA and arrow board combination must be documented as meeting NCHRP Report 350 or MASH crash testing criteria.

10. Operate the TMA and arrow panel from within the cab of the shadow vehicle. This includes the ability to raise/lower the TMA, the ability to raise/lower the arrow board and the ability to change the display on the arrow board.

11. Make the shadow vehicle and TMA available for full inspection upon request by the Engineer prior to the start of Work.

B. Maintain the truck or trailer mounted attenuator.

1. Keep the TMA in effective crashworthy condition for which it is designed throughout the life of the Contract.

2. Repair and/or replace, if necessary, the TMA and/or shadow vehicle should the TMA and/or shadow vehicle become damaged at any time throughout the life of the Contract.

    a. If repaired, submit proper certification to the Engineer for review and acceptance before the TMA/shadow vehicle is allowed back in service on the Project.

3. Make arrangements with the TMA supplier to have replacement components for the TMA readily available for immediate repair.

4. Upon discovery or notification of damage, remove the TMA from the Project immediately and replace with an operable TMA or suspend the Work requiring the TMA.

808.04 Method of Measurement.

The Engineer will measure truck mounted attenuators as the actual number of truck mounted attenuators in place on the roadway and protecting active construction operations per Day. TMA units available, or in storage, but not in use will not be measured.

808.05 Basis of Payment.

Price and payment constitutes full compensation at the Contract Unit Price per each-day for furnishing, positioning and maintaining the TMA and Type C arrow board, shadow vehicle and driver, the necessary repairs or replacement of the unit during its need on the job after damage, removal when no longer required, and for all labor, tools, Equipment and necessary incidentals to complete the Work included in the Items listed below. No payment will be made for TMA units available, or in storage, but not in use.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
808001	FURNISH AND MAINTAIN TRUCK MOUNTED ATTENUATOR, TYPE I	EA-DY
808002	FURNISH AND MAINTAIN TRUCK MOUNTED ATTENUATOR, TYPE II	EA-DY

SECTION 809 – TEMPORARY IMPACT ATTENUATOR

809.01 Description.

Furnish, install, relocate, maintain and remove temporary impact attenuators (TIA) in accordance with the Delaware (DE) MUTCD, the Contract Documents and as directed by the Engineer.

809.02 Materials. Not Applicable.

809.03 Construction.

A. Temporary Impact Attenuator (TIA)

1. Install TIA:

   a. Install TIA in accordance with Section 724, at the location(s) specified in the Contract Documents or as directed by the Engineer.

2. Repair or replace damaged TIAs:

   a. Within 24 hours of notification of damage to a TIA system, repair the TIA in accordance with manufacturer's requirements.

      i. Provide written certification to the Engineer that the impact attenuator has been properly repaired.

   b. If the TIA is not repairable, replace TIA with the on-site stand-by unit.

      i. Remove damaged impact attenuator.

      ii. Install replacement (stand-by) system in accordance with Section 809.03.A.1.

      iii. Provide written certification to the Engineer that the replacement impact attenuator has been properly installed.

3. Relocate TIA

   a. Relocate TIA systems as required by changes in construction phases and/or as shown in the Contract Documents or as directed by the Engineer.

      i. Remove TIA from original location.

   b. Remove anchor pins completely from pavement and fill remaining holes with approved epoxy material. Cutting of pins flush with pavement is not permitted.

      i. Install TIA in new location in accordance with Section 809.03.A.1.

      ii. Provide written certification to the Engineer that the relocated impact attenuator has been properly installed.

4. Remove TIA

   a. Remove TIA systems no longer needed from the roadway at the direction of the Engineer.

      i. Upon removal of the TIA system, remove anchor pins completely and fill remaining holes with approved epoxy material. Cutting of anchor pins flush with pavement is not permitted.

B. Sand Crash Cushions

1. Furnish and install sand crash cushions.

   a. Install sand crash cushions at the location(s) specified in the Contract Documents or as directed by the Engineer.

   b. Install sand crash cushions in accordance with the manufacturer's installation instructions.

2. Replace damaged sand crash cushions.

a. Within 24 hours of notification of damage to a sand crash cushion array, replace the damaged drum(s) in the array in accordance with manufacturer's requirements.

3. Relocate sand crash cushions.

a. Relocate sand crash cushion arrays as required by changes in construction phases and/or as shown in the Contract Documents or as directed by the Engineer.

i. Remove array from original location.

ii. Install array in new location in accordance with Section 809.03.B.1.

4. Remove sand crash cushions.

a. Remove sand crash cushion arrays no longer needed from the roadway at the direction of the Engineer.

809.03.1 Equipment.

A. Temporary Impact Attenuator (TIA)

1. Furnish TIA in accordance with Section 724 of the type specified in the Contract Documents and for the design speed of the roadway on which the TIA is to be used.

a. Furnish TIA that is designed and constructed so there is no solid debris on the roadway after a head-on or side angle impact.

b. Ensure dimensional requirements, if any, be as noted in the Contract Documents.

c. On the nose of the TIA facing traffic, install ASTM D4956 Type IV retroreflective sheeting consisting of alternating 3 inch wide yellow and black stripes positioned at a 45 degree angle with the stripes pointing down towards the side where traffic is to pass the impact attenuator. Cover the entire nose of the attenuator with retroreflective sheeting.

2. Meet the crash testing requirements of NCHRP Report 350 or MASH.

a. Submit appropriate eligibility letters in accordance with Section 801.02.

b. Submit shop drawings and manufacturer's installation instructions.

3. Furnish one complete replacement (stand-by) impact attenuator system of each type used

a. Store replacement TIAs on-site or at Contractor's yard

B. Sand Crash Cushions

1. Furnish sand crash cushions as specified in the Contract Documents consisting of an array for the design speed of the roadway on which they are to be installed.

a. Use sand crash cushions only when specified in the Contract Documents or approved by the Engineer.

b. Furnish, in each sand crash cushion, a sand/salt mixture.

i. Clean, loose sand with a density of 100 pounds per cubic foot and a moisture content of no more than 3 percent.

ii. Provide sand mixture containing 10 percent rock salt by volume.

iii. Provide certification to the Engineer that the sand/salt mixture meets these requirements prior to installing the sand crash cushion array.

2. Meet the crash testing requirements of NCHRP Report 350 or MASH.

a. Submit appropriate eligibility letters in accordance with Section 801.02.

b. Submit shop drawings and manufacturer's installation instructions.

3. Furnish one complete replacement (stand-by) sand crash cushion array.
    a. Store replacement array on-site or at Contractor's yard.

809.04 Method of Measurement.

A. Temporary Impact Attenuator (TIA)

1. The Engineer will measure TIAs as follows:
    a. TIAs furnished will be measured as the actual number of TIAs furnished for each type specified in the Contract Documents or as directed by the Engineer.
    b. TIAs installed or relocated will be measured as the actual number of TIAs installed, complete-in-place and accepted

B. Sand Crash Cushions

1. The Engineer will measure Sand Crash Cushions as follows:
    a. Sand crash cushion arrays furnished will be measured as the actual number of individual sand crash cushion barrels furnished and accepted regardless of barrel weight.
    b. Sand crash cushions installed or relocated will be measured as the actual number of individual sand crash cushion barrels installed, complete-in-place and accepted regardless of barrel weight.
    c. When individual sand crash cushions are damaged as a result of a crash, replacement of individual sand crash cushions will be measured as the actual number of individual sand crash cushion barrels replaced, complete-in-place and accepted regardless of barrel weight.

809.05 Basis of Payment.

A. The accepted quantities of temporary impact attenuators or sand crash cushion arrays will be paid for at the Contract Unit Price as specified below.

B. Temporary Impact Attenuator (TIA)

1. Furnish TIA
    a. Price and payment constitutes full compensation at the Contract Unit Price as specified below for furnishing each type of TIA specified in the Contract Documents plus one replacement (stand-by) TIA of each type required in the Contract Documents.
2. Install or relocate TIA
    a. Price and payment constitutes full compensation at the Contract Unit Price as specified below for installing a TIA system in a new location or relocated to a different location on the Project, complete-in-place and accepted, the necessary repairs or replacement of the unit during its need on the job after damaged, removal of the unit when no longer required, cutting of remaining anchor bolts at installation site and for all labor, tools, Equipment and necessary incidentals to complete the Work.

C. Sand Crash Cushions

1. Furnish sand crash cushion
    a. Price and payment constitutes full compensation at the Contract Unit Price as specified below for furnishing individual sand crash cushion barrels complete with sand/salt mixture as specified in the Contract Documents plus one replacement (stand-by) sand crash cushion array with sand/salt mixture.
2. Install or relocate sand crash cushion array
    a. Price and payment constitutes full compensation at the Contract Unit Price as specified below for installing individual sand crash cushion in a new location or relocation of existing sand crash cushion to a different location on the Project, complete-in-place and accepted, the necessary

repairs or replacement of individual sand crash cushion barrels during their need on the job after damaged, removal of the individual sand crash cushions when no longer required and for all labor, tools, Equipment and necessary incidentals to complete the Work.

3. Replace individual sand crash cushion:

   a. Price and payment constitutes full compensation at the Contract Unit Price as specified below for replacing individual sand crash cushion barrels when individual sand crash cushions barrels are damaged in a crash, complete-in-place and accepted, removal and disposal of the damaged barrel(s), installation of the new barrel(s) and for all labor, tools, Equipment and necessary incidentals to complete the Work.

D. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
809001	INSTALL TEMPORARY IMPACT ATTENUATOR	EA
809002	FURNISH TEMPORARY IMPACT ATTENUATOR – GATING, NON-REDIRECTIVE, TEST-LEVEL 2	EA
809003	FURNISH TEMPORARY IMPACT ATTENUATOR – GATING, NON-REDIRECTIVE, TEST-LEVEL 3	EA
809004	FURNISH TEMPORARY IMPACT ATTENUATOR – NON-GATING, REDIRECTIVE, TEST-LEVEL 2	EA
809005	FURNISH TEMPORARY IMPACT ATTENUATOR – NON-GATING, REDIRECTIVE, TEST-LEVEL 3	EA
809006	RELOCATE TEMPORARY IMPACT ATTENUATOR	EA
809007	FURNISH SAND CRASH CUSHION BARREL	EA
809008	INSTALL SAND CRASH CUSHION BARREL	EA
809009	RELOCATE SAND CRASH CUSHION BARREL	EA
809010	REPLACE SAND CRASH CUSHION BARREL	EA

SECTION 810 – TEMPORARY WARNING SIGNS AND PLAQUES

810.01 Description.

Furnish, install, relocate, maintain and remove temporary warning signs and plaques in accordance with the DE MUTCD, the Contract Documents, and as directed by the Engineer.

810.02 Materials.

A. Signs

1. Provide sign Materials meeting the requirements of the DE MUTCD.
2. Submit appropriate FHWA eligibility letters in accordance with Section 801.02.
3. Provide sign sizes and sign legends per the applicable sections in the DE MUTCD, the Contract Documents, and/or the FHWA Standard Highway Signs Book.
    a. Where there may be a conflict between the DE MUTCD, the Contract Documents, and the FHWA Standard Highway Signs Book, the Contract Documents govern.
4. Provide retroreflective sign sheeting that meets the requirements of the DE MUTCD for the type of sign being used.
    a. Sheeting colors based on the requirements of the Delaware DE MUTCD.

B. Ground mounted sign posts.

1. Provide breakaway sign posts that meet the applicable crash testing requirements of NCHRP 350 and/or MASH.
    a. Submit appropriate eligibility letters in accordance with Section 801.02.
2. Provide sign posts that are appropriate for the type and size of sign that will be supported.
3. Ground mounted signs cannot be co-posted with existing regulatory/warning/guide signs.

C. Temporary Sign Stands

1. Provide breakaway/crashworthy temporary sign stands that meet the applicable crash testing requirements of NCHRP Report 350 and/or MASH.
    a. Submit appropriate eligibility letters in accordance with Section 801.02.
2. Provide temporary sign stands that have been crash tested and accepted for the type and size of sign that will be supported.

D. Sign Covers

1. Black plastic trash bags, 3 mils or thicker
2. Black vinyl
3. Black corrugated plastic

810.03 Construction Methods.

A. Temporary Ground mounted signs

1. Mount temporary signs facing traffic for more than three consecutive days on ground mount sign posts.
    a. Temporary sign stands for signs facing traffic for a period longer than three consecutive days (72 hours) may be used in accordance with Section 810.03.B. only in the following situations:
        i. To avoid drilling through permanent concrete to ground mount signs placed on concrete islands in the median of a divided highway or other similar locations.

ii. A documented conflict exists and field adjustments to the sign location cannot be made. Provide documentation of the conflict to the Engineer prior to using the temporary sign stand.

iii. Other unforeseen situations as approved by the Engineer.

2. Install sign posts in accordance with the manufacturer's instructions at the locations depicted in the Contract Documents.

   a. If there is a discrepancy between field conditions and what is shown in the Contract Documents, including the presence of other regulatory/warning/guide signs, adjust the placement of the sign by increasing the placement distance with the approval of the Engineer.

3. Mount the sign at the height specified in the DE MUTCD, measured from the bottom of the sign to top of the roadway or sidewalk surface.

4. When a sign message is not applicable to the Work operation or temporary traffic control setup, it must be completely covered with approved sign cover material.

5. Upon Completion of the Project or construction phase for which the sign was needed, remove the sign and entire length of post, including the section of post embedded in the ground.

B. Temporary signs

1. Mount signs facing traffic for up to three consecutive days on temporary sign stands.

2. Place the sign stand at the depicted location in the Contract Documents or as required by the DE MUTCD.

3. Properly ballast the sign stand in accordance with the manufacturer's requirements and the DE MUTCD.

4. Mount the sign on the stand at the height specified in the DE MUTCD, measured from the bottom of the sign to top of the roadway or sidewalk surface.

   a. Mounting height will depend upon duration of time the sign is facing traffic.

   b. Except for topographic survey operations, do not mount signs on temporary sign stands at heights less than 5 feet, measured from the bottom of the sign to top of the roadway surface.

5. Completely remove any sign and temporary sign stand from the roadway, when that sign is no longer needed for a Work operation or temporary traffic control setup. Moving the sign and stand to the right-of-way line is not acceptable.

6. Do not place temporary sign stands on bicycle lanes, sidewalks or shared use paths in a manner that restricts the use of these locations by pedestrian or bicycle traffic.

C. Maintenance of signs

1. Replace or repair signs blown or knocked over within 24 hours of notification.

2. Within 24 hours of notification, replace or repair signs not meeting the "marginal" criteria of the ATSSA Quality Guidelines brochure, in accordance with Section 801.02.

3. Maintain signs and stands in good working condition at all times including the area around the sign stands, clearing of debris in between the sign posts and on or around the sign stands.

810.04 Method of Measurement.

The Engineer will measure temporary warning signs and plaques as the actual number of signs and plaques in place and facing traffic each day.

810.05 Basis of Payment.

The accepted quantities of temporary warning signs and plaques will be paid for at the Contract Unit Price per each day for those signs in place and facing traffic. Price and payment will constitute full compensation for furnishing signs, sign posts or temporary sign stands as required, installation of sign posts or sign stands as required, ballast

Material, sign covers and complete removal of signs and sign stands or sign posts and for all labor, tools, Equipment and necessary incidentals to complete the Work included in the Items listed below. Payment for maintenance and relocation of signs will be made under Section 801.

ITEM	DESCRIPTION	UNIT
810001	TEMPORARY WARNING SIGNS AND PLAQUES	EA-DY

SECTION 811 – FLAGGERS

811.01 Description.

Furnish necessary personnel and Equipment meeting the requirements of the DE MUTCD for controlling traffic throughout the entire Project.

811.02 Materials. Not applicable.

811.03 Construction.

Flagger Requirements. Provide certified flaggers meeting the requirements of the DE MUTCD.

811.04 Method of Measurement.

The quantity of Flaggers will be measured as the actual number of hours flaggers were flagging traffic.

811.05 Basis of Payment.

A. The accepted quantities of flaggers will be paid for at the Contract Unit Price per hour for each flagger measured and accepted as noted in the table below.

1. Price and payment constitutes full compensation for furnishing flaggers, flagging equipment, retroreflectorized clothing, approved communication devices and certification.

2. Included in the Bid Proposal are the prevailing wages for highway construction as determined by the Department of Labor of the State of Delaware in accordance with Title 29 Del. C. §6960, relating to wages and the regulations implementing that Section.

3. Flaggers must be bid at a minimum equal to the Laborer wage rate and may be bid up to, but not to exceed, 3 times the Laborer wage rate in accordance with the County where the Work is being performed.

4. Flagger overtime must be bid at minimum of 1.45 times, and may be bid up to a maximum of 4.35 times, the Laborer wage rate in accordance with the County where the Work is being performed.

5. When a Contract for a Project contains both Federal Davis-Bacon and State of Delaware prevailing wage standards, the employer's minimum wage obligations are determined by whichever standards are higher.

6. If the Contractor's Bid Price is not within the limits set forth in Section 811.05.A.3. and Section 811.05.A.4, the Department will adjust the bid to the minimum for prices bid below the minimum acceptable bid and to the maximum for prices bid above the maximum allowable bid prior to award of the Contract.

B. Overtime:

1. Payment for overtime will be considered on a weekly basis for time worked in excess of 40 hours for a continuous 7 day period beginning Monday and ending Sunday inclusive.

2. Time worked on other Projects or Work activities other than flagging will not be counted in the normal 40 hours or the overtime.

C. The cost of the flagging operation when performed by others who are not the Contractor's employees will not be included in the 50% subcontracting limit as outlined in Section 108.01.

ITEM	DESCRIPTION	UNIT
811001	FLAGGER, NEW CASTLE COUNTY, STATE	HOUR
811002	FLAGGER, KENT COUNTY, STATE	HOUR
811003	FLAGGER, SUSSEX COUNTY, STATE	HOUR

ITEM	DESCRIPTION	UNIT
811004	FLAGGER, NEW CASTLE COUNTY, HEAVY CONSTRUCTION, STATE	HOUR
811005	FLAGGER, KENT COUNTY, HEAVY CONSTRUCTION, STATE	HOUR
811006	FLAGGER, SUSSEX COUNTY, HEAVY CONSTRUCTION, STATE	HOUR
811007	FLAGGER, NEW CASTLE COUNTY, FEDERAL	HOUR
811008	FLAGGER, KENT COUNTY, FEDERAL	HOUR
811009	FLAGGER, SUSSEX COUNTY, FEDERAL	HOUR
811010	FLAGGER, NEW CASTLE COUNTY, HEAVY CONSTRUCTION, FEDERAL	HOUR
811011	FLAGGER, KENT COUNTY, HEAVY CONSTRUCTION, FEDERAL	HOUR
811012	FLAGGER, SUSSEX COUNTY, HEAVY CONSTRUCTION, FEDERAL	HOUR
811013	FLAGGER, NEW CASTLE COUNTY, STATE, OVERTIME	HOUR
811014	FLAGGER, KENT COUNTY, STATE, OVERTIME	HOUR
811015	FLAGGER, SUSSEX COUNTY, STATE, OVERTIME	HOUR
811016	FLAGGER, NEW CASTLE COUNTY, FEDERAL, OVERTIME	HOUR
811017	FLAGGER, KENT COUNTY, FEDERAL, OVERTIME	HOUR
811018	FLAGGER, SUSSEX COUNTY, FEDERAL, OVERTIME	HOUR
811019	FLAGGER, NEW CASTLE COUNTY, HEAVY CONSTRUCTION, STATE, OVERTIME	HOUR
811020	FLAGGER, KENT COUNTY, HEAVY CONSTRUCTION, STATE, OVERTIME	HOUR
811021	FLAGGER, SUSSEX COUNTY, HEAVY CONSTRUCTION, STATE, OVERTIME	HOUR
811022	FLAGGER, NEW CASTLE COUNTY, HEAVY CONSTRUCTION, FEDERAL, OVERTIME	HOUR
811023	FLAGGER, KENT COUNTY, HEAVY CONSTRUCTION, FEDERAL, OVERTIME	HOUR
811024	FLAGGER, SUSSEX COUNTY, HEAVY CONSTRUCTION, FEDERAL, OVERTIME	HOUR

SECTION 812 – CERTIFIED TRAFFIC CONTROL SUPERVISOR

812.01 Description.

Furnish certified personnel meeting the requirements of the DE MUTCD for the supervision of temporary traffic control installation, maintenance and relocation.

812.02 Materials. Not applicable.

812.03 Construction.

A. Provide a certified Traffic Control Supervisor for the term of the Project as specified by the General Notes in the Contract Documents;

1. The Department accepts certifications for Traffic Control Supervisors from the American Traffic Safety Services Administration (ATSSA).
2. Submit a copy of the certification for the certified Traffic Control Supervisor at the pre-construction meeting
3. The certified Traffic Control Supervisor must check-in and check-out with the Engineer daily before starting Traffic Control Supervisor duties and prior to ending those duties for the day.

B. The responsibility of the certified Traffic Control Supervisor is the maintenance of traffic and temporary traffic control devices throughout the Project;

1. This responsibility includes, but is not limited to:
   a. Supervision of the installation, operations, maintenance and service of temporary traffic control devices and Work zone setups.
   b. Daily maintenance of a log to record maintenance of traffic activities;
      i. Including the number and location of temporary traffic control devices; and
      ii. Times of installation, changes and repairs.
   c. Daily inspection of the temporary traffic control zone, including any detour routes, and documenting any deficiencies, and defining corrective action to address deficiencies.
   d. Serve as the liaison with the Engineer concerning the temporary traffic control devices and the maintenance of traffic.
   e. The Traffic Control Supervisor shall not have any other responsibility other than outlined in this section when paid for under the appropriate Pay Item.
   f. When construction methods require temporary traffic control to extend beyond a 12-hour period on the same Project, a second Traffic Control Supervisor will be required to relieve the original Traffic Control Supervisor.
   g. Traffic Control Supervisors can only serve one Project when being paid for under this Section.

812.04 Method of Measurement.

A. The quantity of certified Traffic Control Supervisors will not be measured.

812.05 Basis of Payment.

A. Payment for ATSSA Certified Traffic Control Supervisor will not be made separately, in accordance with Section 801.

SECTION 813 – TEMPORARY BARRICADES

813.01 Description.

Furnish, install, relocate, maintain and remove temporary barricades in accordance with the DE MUTCD, the Contract Documents and as directed by the Engineer.

813.02 Materials.

A. Temporary Barricades, Type III;

1. Provide Type III barricade in accordance with the DE MUTCD.
2. Provide barricades crashworthy and crash tested in accordance with NCHRP Report 350 or MASH.
    a. Submit FHWA eligibility letters in accordance with 801.02.

B. Provide sign Material that is the same as was crash tested and accepted with the barricade.

813.03 Construction.

A. Temporary Barricades, Type III;

1. Use barricade rails conforming to the DE MUTCD with a minimum rail length of 6 feet without signs and 10 feet when signs are installed on the barricade.
    a. A minimum rail length of 4 feet is required for barricades used for sidewalk closure.
2. Install Type III barricades for road closures, diversion points and/or sidewalk closures in accordance with the DE MUTCD and as required by the Contract Documents or as directed by the Engineer;
    a. Place barricades for road closures such that the barricades cover the entire width of the roadway to be closed from edge-of-pavement to edge-of-pavement.
    b. Place barricades for diversion points to the far right of the travel lane. If a shoulder exists, place the barricade in the shoulder. If no shoulder exists, place the barricade at the edge of the roadway
    c. Place barricades for sidewalk closures such that the barricade(s) cover the entire width of sidewalk to be closed from edge-of-sidewalk to edge-of-sidewalk
    d. Support barricades with approved ballast. Ballast at least two corners of the barricade base.
3. Mount signs on barricades as required by the Contract Documents, the DE MUTCD and/or as directed by the Engineer;
    a. Mount signs on the barricade so that the bottom of the sign is at least 12 inches above the ground or surface.
    b. Mount signs on barricades so that the proper amount of barricade rail material is maintained in accordance with the DE MUTCD.
4. Replace barricades within 24 hours after notification;
    a. When barricades are damaged by traffic.
    b. When barricades do not meet at least the “Marginal” criteria of the ATSSA Quality Guidelines brochure in accordance with Section 801.03.

813.04 Method of Measurement.

Temporary Barricades, Type III. The Engineer will measure temporary barricades, Type III as the actual number of linear feet of barricades along the length of the top rail, in place and facing traffic each day.

813.05 Basis of Payment.

Temporary Barricades, Type III.

A. The accepted quantities of temporary barricades, Type III will be paid for at the Contract Unit Price per linear feet each day for those barricades in place and facing traffic. Price and payment will constitute full compensation for furnishing barricades, ballast Material, installation of barricades and complete removal of barricades and for all labor, tools, Equipment and necessary incidentals to complete the Work included in the Items listed below.

B. Payment for maintenance and relocation of barricades will be made under Section 801.

C. Payment for any signs mounted on barricades will be made under Section 810.

ITEM	DESCRIPTION	UNIT
813001	TEMPORARY BARRICADES, TYPE III	LF-DY

SECTION 817 – PAVEMENT MARKINGS

817.01 Description.

Supply, install, and remove temporary or permanent pavement markings on the individual lifts of pavement material and the final surface of the roadway and install and remove raised/recessed pavement markers as shown in the Contract Documents or as directed by the Engineer.

817.01.1 Definitions.

Temporary Markings – Temporary markings are those markings that replace markings removed by milling or placing of pavement, and are placed on individual sub-lifts of paving materials or on final travel surfaces, and are kept in service for less than thirty (30) days. Apply as specified in the *Delaware Manual on Uniform Traffic Control Devices ("DE MUTCD").*

Permanent Markings – Permanent markings are all other markings that are not temporary markings. Apply permanent markings in accordance with the *DE MUTCD.*

Lane Line – Lane Lines are marking Material placed between lanes of traffic.

Edge Line – Edge Lines are 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.

Center Line – Center Lines are marking Material placed between lanes of traffic traveling in opposite directions on an undivided highway.

No Passing Zones – No Passing Zones apply to any center lines between opposing directions as on a two-lane, two-way roadway in accordance with the *DE MUTCD*, or as directed by the Engineer, for all temporary or permanent markings.

817.02 Materials. Provide Materials as specified in:

Pavement Markings	Section 1071

817.03 Construction.

817.03.1 Equipment.

A. Latex Paint Application Equipment

1. Use Equipment meeting the following minimum requirements to apply latex paint pavement markings:
2. Paint Equipment
    a. Be able to apply double center lines simultaneously unless otherwise approved by the Engineer.
    b. Capability to apply paint and glass beads to pavement at same time, leaving no more than 2 inches of painted line without glass beads at the beginning or end of a line.
    c. Capability of hand gun operation for applying special markings. (This may be a separate piece of Equipment).
3. Truck-Mounted Paint Equipment
    a. Must have steerable gun carriages.
    b. Must apply double center lines simultaneously.
    c. Must be capable of pneumatically applying glass beads 1 inch behind the spray pattern of the paint gun at an average rate of 7 pounds per gallon of pigmented binder
    d. Must have automatic electrically controlled skip line mechanism capable of retracing the existing markings or applying new markings in accordance with the DE MUTCD.

e. The application speed of the paint machine greater than 10 miles per hour is not permitted unless approved by the Engineer.

B. Epoxy Application Equipment

1. Use only application Equipment, approved by the Engineer prior to the start of Work, for the placement of epoxy reflectorized pavement markings.

2. At any time throughout the duration of the Project, provide free access to the epoxy application Equipment for inspection by the Engineer.

3. Use a truck-mounted and self-contained pavement marking machine, specifically designed to apply epoxy resin materials and reflective glass spheres in continuous and skip line patterns. Use only application Equipment that can be maneuvered to the extent that straight lines can be followed and normal curves can be made in a true arc. Use only truck mounted units with accessories that allow for the marking of legends, symbols, crosswalks, and other special patterns.

4. The Engineer may approve the use of a portable applicator in lieu of truck-mounted accessories, for use in applying special markings only, provided such Equipment can demonstrate satisfactory application of reflectorized epoxy markings in accordance with these Specifications.

5. For long line applications use applicators that are capable of installing up to 20,000 linear feet of epoxy reflectorized pavement markings in an 8-hour day and include the following features:

a. Use applicator with the ability to provide individual material reservoirs, or space, for the storage of Part A and Part B of the epoxy resin composition; for the storage of water; and for the storage of reflective glass spheres.

b. Use applicator with heating Equipment of sufficient capacity to maintain the individual epoxy resin components at the manufacturer's recommended temperature for spray application and for heating water to a temperature of approximately 140 degrees Fahrenheit.

c. Gravity drop glass spheres onto 20 mils of epoxy pavement markings to produce a wet-night-reflective pavement marking. Apply the large spheres (Federal Spec. TT-B-1325, Type IV) at a rate of 12 pounds per gallon of epoxy pavement marking material, immediately followed by a second drop of AASHTO M 247 Type 1 glass spheres applied rate of 12 pounds per gallon of epoxy pavement marking material. This application rate and the following gradation is required to conform to FHWA's FP-14: Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects (Type 3 and Type 4 Beads).

d. Use an applicator with metering devices or pressure gauges, on the proportioning pumps. Ensure metering devices or pressure gauges are visible to the Engineer.

e. Use an applicator with all the necessary spray Equipment, mixers, compressors, and other appurtenances to allow for the placement of epoxy reflectorized pavement markings in a simultaneous sequence of operations as described in Section 817.03.4.D.

C. Alkyd Type Thermoplastic Equipment

a. Provide application Equipment conforming to the requirements of this Section and be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be accomplished in a true arc. Provide heating kettle and application Equipment conforming to the requirements of the National Fire Protection Association and of the State.

b. Construct the Equipment used to install hot applied thermoplastic material by Contract under this Section to provide continuous uniform heating to temperatures exceeding 400 degrees Fahrenheit, mixing, and agitation of the material. Ensure the conveying parts of the Equipment between the main material reservoir and the line dispensing device prevent accumulation and clogging. Construct all parts of the Equipment which come in contact with the Material to be easily accessible for cleaning and maintenance. Construct the Equipment so that all mixing and conveying parts up to and including the shaping dies will maintain the Material at the optimum plastic temperature.

817.03.2 General

A. Place all pavement marking and patterns as shown in the Contract Documents, as specified in the DE MUTCD, and as directed by the Engineer.

B. Before starting any pavement markings Work, submit a schedule of operations for the approval of the Engineer. Submit this schedule two (2) weeks prior to the application of the striping.

C. Protect all pavement markings until track free using a method approved by the Engineer. In the event any vehicle crosses wet pavement markings, remove the damaged markings by sand blasting, heat or other methods approved by the Engineer and replace marking.

D. Install all necessary markings before the end of the workday. Whenever Work is interrupted by weather, install the markings as soon as possible. Due to safety requirements, this Section overrules Section 108.03 which prevents Work on Sundays and Holidays.

E. Offset longitudinal lines at least 2 inches from construction joints and 2 inches to the inside of shoulder breaks of pavement.

F. Perform the application of pavement markings in the general direction of traffic. Do not apply pavement markings against the direction of traffic flow.

G. After satisfactory completion of all pavement marking Work and written notification from the Contractor, the Department will test the markings to ensure the minimum retroreflectivity and film thickness values have been met as defined in Section 1071 for the type of marking being tested. The testing will be completed within 30 calendar days from notification. 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 Department-approved 30-meter geometry spectrometer. Five readings will be taken per line per mile. Projects less than 1 mile in length will have a minimum of 5 readings per line. These readings will then be averaged for the overall Project average.

H. Furnish to the Engineer the applicable warranty for the Material to be installed to ensure proper performance.

I. On the pavement marking Equipment, furnish a suitable measuring device capable of determining the total number of linear feet of materials actually applied within a tolerance of ± 2 percent. Calibrate this device at least twice weekly during marking operations. Provide proof of calibration to the Engineer upon request.

817.03.3 Latex Paint

A. Temporary Paint:

1. Apply temporary paint by the same methods as permanent paint, with the exception that temporary paint be applied at approximately 7 mils. The temporary paint application of 7 mils is enough to retain sufficient amounts of beads to remain reflective.

B. Permanent Paint

1. Apply a heated pigmented binder (white and yellow) and optical glass spheres system to highway surfaces with specialized application Equipment.

2. Obtain the reflective surface by applying optical glass spheres in the specified ratio onto and into the pigmented binder after the binder application in one operation using specialized Equipment as described below.

3. During and after Material application, both daylight and nighttime inspections of the markings will be made by the Engineer, and if found to be defective or if they fail in any way to meet these Specifications, such markings will be rejected and shall be replaced at no cost to the Department within the time limit specified by the Engineer.

817.03.4 Epoxy Pavement Markings

A. General

1. At least five (5) Days prior to starting striping, provide the Engineer with the epoxy manufacturer's written instructions for use. Include instructions regarding, but not be limited to: mixing ratios, application temperatures, and recommendations for use of water spray.

2. To the satisfaction of the Engineer, remove tracking marks, spilled epoxy or errantly applied epoxy markings.

3. Do not use the hot water spray in conjunction with markings applications on any pavement surface, or on any existing durable type marking, unless specifically recommended by the manufacturer of the epoxy material.

B. Apply epoxy pavement markings only during conditions of dry weather and on substantially dry pavement surfaces. At the time of installation, ensure the pavement surface temperature be a minimum of 35 degrees Fahrenheit and the ambient temperature be a minimum of 35 degrees Fahrenheit and rising. The Engineer will determine when atmospheric conditions and pavement surface conditions are appropriate to produce satisfactory results.

C. Prepare the surface to which marking Material is to be installed as follows:

1. Clean the pavement or existing durable markings to the satisfaction of the Engineer.

2. Perform surface cleaning and preparation Work only in the area of the epoxy markings application.

3. At the time of application, ensure <u>all</u> pavement surfaces and existing durable markings are free of oil, dirt, dust, grease and similar foreign materials. Waterblasting will not be permitted for removal.

D. Application of White/Yellow Epoxy Reflectorized Pavement Markings

1. Place white/yellow epoxy reflectorized pavement markings at the widths and patterns designated in the Contract Documents.

2. Do not begin markings operations until applicable surface preparation Work is completed and approved by the Engineer.

3. Apply white/yellow epoxy pavement markings at a minimum uniform thickness of 20 mils on all portland cement concrete and bituminous concrete pavement, including Stone Matrix Asphalt.

4. Apply large reflective glass spheres (Federal Spec. TT-B-1325, Type IV) at the rate of 12 pounds per gallon of epoxy pavement marking material, immediately followed by a second drop of AASHTO M 247 Type 1 glass spheres applied at a rate of 12 pounds per gallon of epoxy pavement marking material. Uniformly cover the length and width of the pavement marking with the glass spheres.

E. Application of Black Epoxy Contrast Pavement Markings

1. Place black epoxy contrast pavement markings at the widths designated in the Contract Documents.

2. Do not begin markings operations until applicable surface preparation Work is completed, and approved by the Engineer.

3. Apply black epoxy contrast pavement markings at a minimum uniform thickness of 20 mils on all Portland cement concrete surfaces followed by a single drop of graded black aggregate.

F. Repair epoxy reflectorized pavement markings, which after application and curing are determined by the Engineer to be defective and not in conformance with this Section. Perform the repair of defective markings to the satisfaction of the Engineer as follows:

1. Insufficient film thickness (less than 20 ± 1 mils as applicable), insufficient line widths, insufficient glass bead coverage or inadequate glass bead retention:

a. Prepare the surface of the defective epoxy marking by shot blasting, sand blasting, or water blasting. No other cleaning methods will be allowed. Perform surface preparation to the extent

that a substantial amount of the reflective glass spheres are removed and a roughened epoxy marking surface remains.

b. Immediately after surface preparation, remove loose particles and foreign debris by brooming or blasting with compressed air.

c. Make the repair by re-striping over the cleaned surface, in accordance with the requirements of this Section and at a full 20 ± 1 mils minimum line thickness as required.

2. Uncured or discolored epoxy (brown patches); insufficient bond to pavement surface (or existing durable marking).

a. Uncured epoxy is defined as applied Material that fails to cure (dry) in accordance with the marking manufacturers requirements or applied Material that fails to cure (dry) within a reasonable time period under actual field conditions, as defined by the Engineer.

b. Discoloration (brown patches) is defined as localized areas or patches of brown or grayish colored epoxy marking Material. These areas often occur in a cyclic pattern and also, often are not visible until several days or weeks after markings are applied.

c. Repair the uncured, discolored or insufficiently bonded epoxy as follows:

i. Completely remove and clean the defective epoxy marking to the underlying pavement surface to the satisfaction of the Engineer.

ii. Remove the defective area plus any adjacent epoxy pavement marking Material extending one foot in any direction.

iii. After surface preparation Work is complete, re-apply the epoxy over the cleaned pavement surface in accordance with the requirements of this Section.

3. Repair or replace to the satisfaction of the Engineer other defects not noted above, but determined by the Engineer to need repair.

4. Perform all Work in conjunction with the repair or replacement of defective epoxy reflectorized pavement markings at no additional cost to the State.

G. Reflectivity Tests:

a. The Department will test the retroreflectivity of epoxy pavement markings in accordance with Section 817.03.2. Provide minimum retroreflectivity values for epoxy pavement markings conforming to Section 1071 - Pavement Markings.

b. Remove and replace, at the Contractor's expense, any pavement marking installed that does not meet the average minimum initial reflectivity numbers specified in Section 1071 - Pavement Markings.

817.03.5 Thermoplastic Pavement Markings

A. Alkyd Type Thermoplastic Material

1. Do not apply thermoplastic pavement markings on Portland cement concrete.

2. For optimum adhesion, install the thermoplastic material in a molten state at a temperature between 400 to 425 degrees Fahrenheit on a clean, dry, and solvent free surface. Clean off pavement surface dirt and grease where necessary by approved removal methods. Do not apply thermoplastic pavement marking materials when pavement temperatures are below 50 degrees Fahrenheit or when the surface of the pavement shows evident moisture.

3. If recommended by the Manufacturer of the thermoplastic material, and if required by the Department, apply a primer sealer prior to the installation of thermoplastic material on the pavement. Ensure that the primer is void of solvent and water prior to the installation of thermoplastic material.

4. Readily apply the material 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.

5. 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. Ensure that new material bonds to the old line in such a manner that no splitting or separation takes place.

6. Apply glass spheres to the surface of the completed stripe by drop-on or pressure spray methods at an approximate uniform rate of 0.1 pounds of glass spheres every square foot (0.033 pounds per foot of 4 inches) from an automatic dispenser attached to the striping machine so that the glass spheres are dispensed closely behind the installed line. Use only the glass sphere dispenser equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.

7. Marking Patterns

    a. Provide a thickness measurement, prior to application of drop-on glass beads, of 0.125 inches for transverse lines and symbols (crosswalks, stop bars, and arrows) and 0.090 inches for longitudinal lines (lane lines, center lines, and edge lines).

    b. Calibrate 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, remove the sample by making sharp cuts with a knife and measure the stripe plus base with a micrometer or vernier calipers with a proper correction for the base.

    c. Offset longitudinal lines in accordance with Section 817.03.2. Provide openings 6 inches in length at 20 foot intervals in edge lines placed on the inside of super elevated curves to prevent ponding of water on the pavement surface.

    d. The finished lines are required to have well-defined edges.

8. Reflectivity Tests:

    a. The Department will test in accordance with Section 817.04.A. the retroreflectivity of thermoplastic pavement markings for minimum requirements as specified in the Section 1071-Pavement Markings.

    b. For thermoplastic markings with retroreflectivity readings below the minimums specified in Section 1071- Pavement Markings and above 125 millicandellas, payment for the markings will be reduced as described under 817.04.

    c. Remove and replace, at the Contractor's expense, any pavement marking installed that has an average minimum initial reflectivity below 125 millicandellas.

9. Guarantee for Alkyd Type Thermoplastic Material

    a. Acceptance of the Work 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.

    b. Provide warranty for the thermoplastic markings Material furnished and installed under this Contract 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 adhesion to the pavement materials, vehicular damage, and wear for a period of 180 days of observation period.

    c. Replace any markings that have not performed satisfactorily during the 180-day observation at no expense to the Department.

    d. Perform marking replacements in accordance with the requirements specified in this Section, including but not limited to possible surface cleaning, pavement marking removal, seasonal and

weather limitations, etc.

B. Preformed Thermoplastic Markings

1. Apply the markings in accordance with the Manufacturer's recommendations on clean and dry surfaces.

2. Use preformed retroreflective thermoplastic Material that is fusible to the pavement by means of a propane torch in accordance with the marking Manufacturer's requirements. Preheat the surface to remove any latent moisture just prior to the placement and installation of the marking.

3. Do not place any markings when the ambient temperature is below 40 degrees Fahrenheit. Store the Material in a location above 55 degrees Fahrenheit until just before application.

4. At no cost to the State, secure the supplier's technical services as required by the Engineer.

5. Reflectivity Tests:

a. The Department will test in accordance with Section 817.03.2. The retoreflectivity of preformed thermoplastic markings for minimum requirements as specified in the Section 1071 - Pavement Markings.

b. Remove and replace, at the Contractor's expense, any preformed thermoplastic markings installed that has an average minimum initial reflectivity below the values defined in Section 1071 - Pavement Markings.

C. Extend warranty to the Department that the installed retroreflective preformed thermoplastic pavement markings are free of defects, as hereafter defined, for a period of one winter season beginning at the initial acceptance of the marking installation by the Department.

1. The initial acceptance of the marking installation will occur upon the satisfactory correction of all deficiencies noted in the marking installation during the Final Inspection of the Project.

2. Warrant 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 adhesion to the pavement Materials, vehicular damage, and wear from maintenance activities including snow plowing.

D. Repair all defective areas identified by the Department after initial installation or during the warranty period.

1. Begin all repairs immediately following the notice to the Contractor by the Department unless weather limitations prevent the corrective Work.

2. Should the Contractor not commence Work within the period stated in the notice, weather permitting, and pending severity, the Department reserves the right to remedy the condition and charge the Contractor for the Work.

3. Perform corrective Work as recommended by the Manufacturer of the marking material and approved by the Department.

4. Give the Department notice before beginning corrective Work to allow for inspection of the operation.

5. Perform all remedial Work including but not limited to, removal, Material, maintenance of traffic, and reconstruction at no cost to the State.

817.03.6 Pavement Marking Tape

A. Temporary Tape

1. Place temporary pavement marking tape in Work zones at the locations depicted in the Contract Documents and as required by the Engineer.

2. Configure pavement marking configurations in accordance with the DE MUTCD.

3. Apply pavement markings to clean, dry surfaces in accordance with the Manufacturer's installation instructions or a method approved by the Engineer.

4. Maintain and replace temporary pavement marking tape without additional compensation until the markings are no longer required.

5. Reflectivity Tests:

   a. The Department will test in accordance with Section 817.03.2. The retoreflectivity of temporary pavement marking tape for minimum requirements as specified in the Section 1071 - Pavement Markings.

   b. Remove and replace, at the Contractor's expense, any temporary marking tape installed that has an average minimum initial reflectivity below the values defined in Section 1071 - Pavement Markings.

B. Preformed Marking Tape

1. Certify the Contractor, by the Manufacturer, in the installation of the pavement marking Material prior to the start of the markings.

2. Install the pavement marking Material in accordance with the Manufacturer's published recommendations.

3. Arrange to have a Manufacturer's representative, or qualified personnel, onsite to oversee all operations and to ensure successful installation of markings, training, product information, and problem solving as required by the Engineer.

   a. Qualifying Personnel. Submit for approval, a minimum of 5 years of documented history with experience in the use and placement of the material. A manufacturer's letter of certification as an approved installer may also be accepted.

4. Perform installation of the pavement markings in a neat and workman-like manner. Pre-mark the pavement to ensure correct location of markings and such layout Work is incidental to the price bid for the pavement marking Items. The method for pre-marking should be as recommended by the Manufacturer. A thin layer of paint as a pre-marking is not recommended. Take care to ensure that the leading edges of the markings are secured to the pavement.

5. General application rules:

   a. Do not apply tape when the air and surface temperature is below 40 degrees Fahrenheit.

   b. Apply tape on a clean and dry pavement surface after 24 hours of dry weather and no rain is expected for the day.

   c. When not placed by inlaid method, use a surface preparation adhesive.

   d. Do not overlap tape, use a butt splice.

   e. Do not apply tape on longitudinal joints or cracks.

   f. Do not apply tape on deteriorating pavement surfaces.

   g. Ensure that the markings are ready for use by traffic immediately upon application.

6. Inlay into Fresh Bituminous Concrete

   a. When marking tape is specified in the Contract for newly paved asphalt concrete surfaces, apply the marking tape before traffic is allowed on the freshly paved surface.

   b. Inlay the pavement markings in the fresh pavement surface during final rolling of the mat, in accordance with the marking Manufacturer's recommendations.

   c. Inform the Engineer how the pavement mats will be placed to avoid applying the tape on longitudinal joints or cracks and maintain correct marking location.

d. Pre-mark the pavement and install the markings such that all markings are inlaid into the hot pavement prior to the finish rolling. Do not perform paving operation unless the stripping crew, marking Material and Equipment are on the Project site.

e. General procedure for inlay application on fresh asphalt surfaces:

i. Apply tape after the compaction roller and before the finish roller using minimum water, slow speed and no vibration.

ii. Apply tape using Equipment recommended by Manufacturer

iii. Tamp the marking tape by the finish roller rolling in the same direction the tape was applied. A separate roller of a size approved by the tape Manufacturer may be required to meet the Manufacturer's requirements.

iv. Roll the tape with a minimum roller speed to prevent wrinkling of the tape.

v. Apply marking tape only when the mat temperature is within the range specified by the tape manufacturer.

vi. NOTE: Even though the tape will stand these high temperatures, the contractor is to use caution to assure the asphalt is firm enough to walk on above 140 degrees Fahrenheit.

7. Placement on new Portland cement concrete (P.C.C.) Pavement

a. When marking tape is specified in the Contract for new P.C.C. pavement surfaces, apply the marking taper after the concrete has adequately cured as determined by the Engineer and prior to opening to traffic.

b. Remove any membrane curing compounds from the P.C.C. surface by sandblasting prior to applying the marking tape. Sweep and clean the road surface using high pressure air after curing compound removal.

c. Use only the primer/solvent specified by the Manufacturer for the pavement surface.

d. Apply the tape using an approved applicator.

e. Tamp the tape with a roller tamper cart with a minimum 200 pound load or by slowly (2-3miles per hour) driving over the tape with a vehicle tire. Do not twist or turn on the tape. Perform a minimum three passes back and forth over the tape. Thoroughly tamp all edges of tape.

8. Placement on Existing Pavement

a. Ensure that the pavement surface is free of any existing markings when the tape is specified in the Contract to be placed on an existing pavement.

b. Sweep and clean the road surface using high pressure air.

c. Use only the primer/solvent specified by the Manufacturer for the pavement surface.

d. Apply the tape using an approved applicator.

e. Tamp the tape using a roller tamper cart with a minimum 200 pound load or by slowly (2-3 miles per hour) driving over the tape with a vehicle tire. Do not twist or turn on the tape. A minimum of three passes back and forth over the tape will be required. Thoroughly tamp all edges of the tape.

9. Reflectivity Tests:

a. The Department will test in accordance with Section 817.03.2. The retoreflectivity of permanent pavement marking tape for minimum requirements as specified in the Section 1071 - Pavement Markings.

b. Remove and replace, at the Contractor's expense, any preformed pavement marking tape installed that has an average minimum initial reflectivity below the values defined in Section 1071 - Pavement Markings.

C. Blackout Tape

1. Use blackout tape to completely cover the existing pavement markings. Use tape that is 2-inches wider than the existing pavement marking to ensure complete coverage. Prepare pavement surface, apply tape and remove tape as per the Manufacturer's recommendations. Correct, at the Contractor's expense, any failure of the tape to remain in place or adequately mask the existing pavement markings.

817.03.7 If any of the existing pavement markings are damaged or removed due to the removal of blackout tape, restore the existing markings as directed by the Engineer at the Contractor's expense.

817.03.8 Raised/Recessed Pavement Markers

A. Install raised/recessed pavement markers as specified below:

1. Saw cut the pavement to match the bottom contour of the marker housing using a saw and blade suitable for the pavement Material being sawed.

a. The depth of the cut slot must allow the housing to be set in epoxy, with leveling lugs resting on the pavement surface, so that the front edge of marker is at or below the surface of the pavement.

b. Repair excessive saw cuts to the satisfaction of the Engineer.

c. Only use the truck mounted saw cutting devices. Do not use walk behind or hand cutting saw devices.

2. When cutting is complete, clean the slot as recommended by the Manufacturer of the epoxy Material.

3. Install the epoxy and pavement marker in the prepared contour slot in the pavement per the Manufacturer's recommendations. Do not leave the prepared contour slot unfilled.

B. Replace existing raised/recessed pavement marker lenses as specified below:

1. Remove the existing reflective pavement marker lenses from the metal housing.

2. Clean the metal casing as recommended by the Manufacturer prior to the replacement of the new lenses.

3. Apply an approved epoxy adhesive to the back of the new lenses and install the new lens.

C. Remove existing raised/recessed pavement marker lens or housing assembly as specified below:

1. If only lens removal is required by the Contract Documents, remove the existing lens in a manner that will not cause damage to the casting and in accordance with the Manufacturer's recommendations.

2. If the entire housing is required to be removed, remove the entire housing from the pavement surface using a method that is approved by the Engineer. Fill the void in the pavement surface with pavement patching material as required by the Engineer.

817.03.9 Removal of pavement marking paint or tape

A. General pavement marking removal requirements:

1. Perform the removal operation in a manner that will not damage the pavement surface.

2. Collect and dispose of all shot/abrasive grit and pavement marking Materials removed from the pavement surface. Do not wash or sweep such Material to the roadside.

3. After removal of striping on bituminous concrete, use an approved flat black paint or asphalt sealer to cover any exposed aggregate or embedded paint.

B. Use shot/abrasive grit blasting or water blasting Equipment to remove pavement marking paint and epoxy resins.

C. Burning or grinding (erasing machines) Equipment may be used in lieu of shot/abrasive grit blasting or water blasting for the removal of alkyd thermoplastic markings, temporary marking tape, or preformed marking tape.

817.04 Method of Measurement.

A. The quantity of pavement markings of the type specified in the Contract Documents will be measured as the number of linear foot of pavement marking line installed and accepted and as the number of square feet of pavement marking symbols or legend, installed and accepted.

1. The linear foot of line refers to all lines parallel to the center line. The square foot of symbols and legend refers to all STOP bars, transverse lines, arrows, and words. Measure all symbols according to the following square foot values.

Straight Arrow..... 12.5 ft²

Left and Right Arrow Symbol..... 15.5 ft²

Combination Arrow ..... 20 ft²

"Only" Legend ..... 23 ft²

"School" Legend ..... 35 ft²

"Stop" Legend ..... 23.5 ft²

8” Transverse Line .....0.66 ft² / linear foot

12” Transverse Line .....1.00 ft² / linear foot

16” Transverse Line .....1.33 ft² / linear foot

24” Transverse Line .....2.00 ft² / linear foot

"R X R" Railroad Crossing Symbol ..... 69 ft²

Left and Right 18’ Lane Reduction Arrow .....40.9 ft²)

B. The quantity of bike symbol, pedestrian symbol, and handicap symbol will be measured as the actual number of each symbol furnished, installed, complete in place, and accepted. The dimensions for the symbol/legends are as follows:

Bike Rider with Helmet will be 3’ x 6’ with a 2’ x 6’ Arrow Symbol.

Pedestrian.....4’ x 8’

Handicap Symbol.....40” x 40”

Shared Lane Marking ..... 40” x 112”, 4” to 5”W chevrons

C. The quantity of blackout tape will be measured as the actual number of linear feet of blackout tape installed, complete in place and accepted.

D. The quantity of raised/recessed pavement markers installed or removed will be measured as the actual number of each pavement marker installed or removed, complete in place and accepted.

E. The quantity of raised/recessed pavement marker lenses replaced or removed will be measured as the actual number of each lens removed, installed, complete in place and accepted. For replacement of existing lenses, measurement will be made once for the removal of the existing lens and subsequent installation of the new lens.

F. The quantity of pavement marking removal will be measured as the number of square feet of pavement marking removed and accepted. The area of the line will be calculated by multiplying the nominal width of line times the length. The area of symbols will be as specified in Section 817.04.A.1.

817.05 Basis of Payment.

A. The quantity of pavement marking paint and pavement marking tape of the type specified in the Contract Documents will be paid at the Contract Unit Price per linear foot for pavement marking lines and the Contract Unit Price per square foot for symbols and legend. The quantity of bike symbol, pedestrian symbol, and handicap symbol will be paid for at the Contract Unit Price per each. The Pay Items and associated units of measure are listed in the table below. Price and payment constitute full compensation for the technical representative, furnishing and installing all Materials; for preparation of the pavement including any required sandblasting, sweeping and cleaning or removal of curing compound on P.C.C. pavement; 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 as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
817001	PAINTING OF WHITE OR YELLOW, SYMBOL/LEGEND	SF
817002	PERMANENT PAVEMENT STRIPING, SYMBOL/LEGEND, ALKYD-THERMOPLASTIC	SF
817003	TEMPORARY MARKINGS, PAINT, 4”	LF
817004	TEMPORARY MARKINGS, PAINT, SYMBOL/LEGEND	SF
817005	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, 5”	LF
817006	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, 12”	LF
817007	RETROREFLECTIVE PREFORMED PATTERNED MARKINGS, 12”	LF
817008	BLACKOUT TAPE, 6”	LF
817009	TEMPORARY MARKINGS, TAPE, 4”	LF
817010	TEMPORARY MARKINGS, TAPE, WORD/SYMBOLS	SF
817011	BLACKOUT TAPE, 8”	LF
817012	RETROREFLECTIVE PREFORMED PATTERNED MARKINGS, SYMBOL/LEGEND	SF
817013	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, WHITE/YELLOW, 5”	LF
817014	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, WHITE/YELLOW, 10”	LF
817015	PREFORMED RETROREFLECTIVE THERMOPLASTIC MARKINGS, BIKE SYMBOL	EACH
817016	PREFORMED RETROREFLECTIVE THERMOPLASTIC MARKINGS, PEDESTRIAN SYMBOL	EACH
817017	PREFORMED RETROREFLECTIVE THERMOPLASTIC MARKINGS, HANDICAP SYMBOL	EACH
817018	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 3”	LF
817019	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 5”	LF
817020	RETROREFLECTIVE PREFORMED PATTERNED MARKINGS, 5”	LF
817021	RETROREFLECTIVE PREFORMED PATTERNED MARKINGS, 10”	LF
817022	RETROREFLECTIVE PREFORMED PATTERNED MARKINGS, 8”	LF
817023	RETROREFLECTIVE PREFORMED PATTERNED MARKINGS, 13”	LF
817024	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 9”	LF
817025	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 14”	LF

817026	PAINTING OF WHITE OR YELLOW, 5" LINE	LF

B. 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:

$$\frac{A \times B}{C}$$

Where:

1. A = Average measured reflectivity readings*
2. B = Contract bid price for striping**
3. C = Required minimum initial reading
4. *= Must be greater than or equal to 125 millicandellas
5. ** = Item Bid Price; not Material cost

C. The quantity of raised/recessed pavement markers installed, replaced or removed will be paid at the Contract Unit Price per each for the Pay Items listed below. Price and payment constitute full compensation for furnishing all Materials, installation, saw-cutting, cleaning, disposal of discarded Materials, removal and replacement of existing lenses, removal of the lens housing, restoration of the existing pavement, and for all labor, tools, Equipment and necessary incidentals required to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
817027	RAISED/RECESSED PAVEMENT MARKER	EACH
817028	REPLACEMENT OF RAISED/RECESSED PAVEMENT MARKER LENS	EACH
817029	REMOVAL OF RAISED/RECESSED PAVEMENT MARKER LENS	EACH
817030	REMOVAL OF RAISED/RECESSED PAVEMENT MARKER HOUSING	EACH

D. The quantity of pavement marking removal will be paid at the Contract Unit Price per square foot for the Pay Items listed below. Price and payment constitute full compensation for furnishing all Materials, removing the pavement markings, disposing of the removed marking Material, covering the exposed aggregate with an approved flat black paint or asphalt sealer, and for all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
817031	REMOVAL OF PAVEMENT STRIPING	SF
817032	REMOVAL OF PAVEMENT MARKING TAPE	SF

SECTION 818 – SIGN PANELS

818.01 Description.

Fabricate and furnish sign panel overlays and new sign panels constructed of either flat sheet aluminum panels or extruded aluminum panels in accordance the Contract Documents, the Delaware MUTCD and as directed by the Engineer.

818.02 Materials.

A. Sign Sheeting

1. Provide wide angle, prismatic, retroreflective sheeting consisting of prismatic lens elements with a distinctive interlocking pattern visible from the face of a smooth surface, unless otherwise specified on the Plans.
2. Equip the sheeting with a pre-coated adhesive protected by an easily removable liner.
3. Retroreflective properties will be measured in Minimum Coefficient of Retroreflection Ra (cd/lux/m^2):
   a. The coefficients of retroreflection observation angles are 0.2°, 0.5°, 1.0°.
   b. The coefficients of retroreflection entrance angles are -4° and 30°.
4. Send a letter of certification stating that the sign sheeting Materials meet the required Minimum Coefficient of Retroreflection described in the charts below. Send the letter shall to:

   Delaware Department of Transportation
   Signs and Markings Section
   Attn: Traffic Operations Manager
   P.O. Box 778
   Dover, Delaware 19901

   a. The coefficients of retroreflection, R_A, are not to be less than the minimum values specified in when tested in accordance with ASTM E 810.

5. Have the sheeting manufacturer submit with each lot or shipment, a certification that states the Material supplied will meet all the requirements listed herein.
6. The Department will date all signs at the time of application. That date constitutes the start of the field performance obligation period.
7. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retroreflection is less than the minimum specified for that sheeting during that period listed below:
   a. 85% of values listed in Type IV after 10 years
   b. 80% of values listed in Type IX after 12 years.
   c. 80% of values listed in Type XI after 12 years.

   Natural causes include effects of exposure to weather. Natural causes exclude (without limitation) damage from exposure to chemicals, abrasion and other mechanical damage (such as from fasteners used to mount the sign, collisions or mishandling), vandalism, or malicious mischief.
8. Where it can be shown that retroreflective signs supplied and used according to the sheeting manufacturer's recommendations, have not met the performance requirements of this Specification, the sheeting manufacturer is responsible to cover restoration costs as follows for sheeting shown to be unsatisfactory during:
   a. The entire 12 years (Types IX and XI) and 10 years (Type IV): the sheeting manufacturer will replace the sign in its entirety inclusive of the sign panel, sign sheeting, labor, and temporary traffic control required to restore the sign surface to its original effectiveness.
   b. Non-reflective black Material that is used on the signs will carry the same warranty period and replacement obligation. This Material will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that it is visibly cracked or has experienced shrinkage of more than 1/8 inch from the edge of the metal it is applied.

B. Aluminum Sign Panels
   1. Aluminum sheet type conforming to ASTM Designation B209 (alloy 6061-T6 or 5052-H38).
      a. Provide the minimum panel sheet thickness as specified in the Contract Documents.
      b. Fabricate stringers or horizontal structural sign supporting members and vertical connections of 6061-T6 or 6062-T6 ASTM B221 aluminum alloy.
      c. Fully reflectorize all sign panels unless otherwise indicated on the Plans.
      d. Sign hardware
         i. Stainless steel or;
         ii. Galvanized steel or;
         iii. 2024-T4 aluminum alloy ASTM B211 or ASTM B221.
      e. Hardware for attachment to overhead members shall be Type 304 passivated stainless steel, except that stainless steel lock washers shall be Type 302 stainless steel alloy.
      f. Connections to the sign support structure shall be of steel conforming to the requirements of ASTM Designation A36 and galvanized to the requirements of ASTM Designation A123.

C. Extruded Aluminum Sign Panels
   1. Provide extruded aluminum sign panels and edge strips conforming to B 221, alloy 6063 T6. (See Extruded Aluminum Detail Sheets)
   2. Provide clear anodized hardware, conforming to one of the following: ASTM B 209, alloy 2024 T4; ASTM B 211, alloy 2024 T4, 6262 T9, 6061 T6, 7075 T6 or 2017 T4.

D. Sign Panel Overlays
   1. Flat aluminum sheet conforming to ASTM Designation B209 (Alloy 6061-T6).
   2. Minimum panel sheet thickness is 0.080 inch.

818.03 Construction.

818.03.1 Applicable Documents.

The following documents, of the versions in effect on the date of advertisement of bids or request for proposal, form a part of this Specification to the extent specified herein.

- ASTM D 4956 Standard Specification for Retroreflective Sheeting for Traffic Control
- ASTM E 810 Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting
- AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals
- Delaware Manual on Uniform Traffic Control Devices (MUTCD)
- FHWA Standard Highway Signs and Markings

818.03.2 Submittals.

Submit Working Drawings in accordance with the latest version of the FHWA Standard Highway Signs and Pavement Markings manual and clearly indicate the following:

- Sheeting type (legend and background)
- Colors
- Legend (Standard Alphabet series, Clearview series, etc.) as well as style and type
- Proposed spacing of letters
- Locations and arrangements of symbols and borders

818.03.3 Design.

A. Sheet Aluminum Sign Panels
   1. Design sign panels and their connections to supports for applicable loadings and allowable stresses specified for the supports.
      a. All panels, stiffeners and sub-framing conforming to any pertinent requirements set forth in the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals" with subsequent revisions.
      b. Submit detail drawings showing the details for fabrications of the panels and support connections for

prior approval.

2. Fabricate sign panel sections from standard width, readily available, aluminum sheets not less than 3 feet-0 inches wide and not more than 5 feet-6 inches wide, except that not more than one sheet of 2 feet-0 inches minimum width will be permitted.
3. Sections 12 feet and under in height:
   a. Fabricate sign panel sections up to (12) feet in height using flat aluminum sheets that run from the top edge to the bottom edge of the sign face without horizontal joints.
4. Sections over 12 feet in height:
   a. Fabricate sign panel sections over twelve (12) feet in height from two or more sheets with horizontal joints which butt and fasten securely together and can be disassembled for simplified handling and erection in the field.
      i. Locate each horizontal joint in sign panel sheets at the point of contraflexure in the sign face.
      ii. Fabricate the bottom sheet(s) from 12 foot tall Material.
      iii. Height of the smaller top sheet must not be less than 2 feet.
      iv. Adjustment in sheet heights is permitted to avoid conflict with direct applied sign face copy.
5. Fasteners and Backing Strips
   a. Provide sign panel sections with suitable fastenings, as shown on the Plans, to permit easy attachment to the supporting frames.
   b. Design fastenings to carry the full design load with a factor of safety of 1.6 against the minimum yield stress of the materials.
6. Provide sign panel sections with backing strips at the joints, held firmly in place to keep the abutting panel sections in proper alignment.
   a. Apply all sign panel fastenings and backing strips, with the exception of the fastening of letters, symbols and border to the sign face, without causing visible projections or indentations of the sign face.
   b. Design each sign panel section to engage and hang from two or more horizontal structural members of the supporting frame.
   c. The method of fastening to obtain secure close butt joints between panels may vary as recommended by the fabricator.
7. Supporting Frame
   a. Construct the supporting sign frame to consist of horizontal and vertical stringers as shown on the Plans.
   b. Fabricate the horizontal members of the supporting sign using new Material in one piece.
   c. Where large signs necessitate splicing the stringers, locate splices at points of contraflexure and keep the number of splices to a minimum.
   d. Splice must develop full section of member.
8. Sign Panel Size:
   a. Fabricate sign panels that include a reflective sheeting background, complete with demountable copy or direct applied or silk screened copy.
   b. Base the sizes of sign panels having copy as specified on the Plans on the manufacturer's spacing charts.
   c. Place all letters in accordance with manufacturer's spacing charts.
   d. Use six (6) inch increments for the overall horizontal and vertical dimensions.

B. Extruded Aluminum Sign Panels
1. Extruded aluminum sign panels have copy as specified on the Plans.
2. A maximum thickness of 0.100 inch is permitted for the exposed surface of extruded aluminum sign panels. Equip with notched corners. No other type corners are acceptable.
3. Fabricate extruded aluminum sign panels from individual extrusions that are 12 inches wide. Assemble extruded aluminum sign panels such that the individual extrusions are connected to one another horizontally with no vertical joints. Provide attachment of individual extrusions to one another in accordance with the applicable details. Use only straight and flat extrusions.
   a. Exceptions will be made to allow 6 inch wide extruded sections in cases where height of the sign or exit panel dictates. No more than one 6 inch panel is allowed per individual sign or exit panel.
4. Apply the reflective sheeting to extruded panels so that it extends approximately 3/8 inch over each side in the narrow direction and is adhered to the panel.

5. Place an edge strip on both sides of all extruded panel signs.

818.03.4 Construction Methods.

A. Sign Face Finishing
   1. Provide clean-cut, sharp messages for all retroreflective sheeting, backgrounds, letters, numerals, symbols, and borders on all signs as indicated on the Plans.
   2. After the sign panel has been degreased and etched, apply retroreflective sheeting to the aluminum panels in accordance with sheeting manufacturer's recommendations.
      a. Application of the sheeting is not permitted when the temperature is less than 50 degrees Fahrenheit.
   3. Employ the height of characters and the alphabet series for the signs in conformance to the Plans and their references.
   4. Use on the sign panels, alphabet series from the publication titled "Standard Alphabets for Highways Signs" of the Federal Highway Administration.
   5. Prepare Working Drawings that clearly indicate the proposed spacing of the letters and the locations and arrangements of symbols and borders.
   6. Whenever it is necessary to construct the background of a sign face with two or more pieces of retroreflective sheeting, they must be carefully matched for color prior to application and sign fabrication, to provide uniform appearance and brilliance, day and night. Rotate and mount 180 degrees with respect to that adjacent section each full width section of retroreflective sheeting taken consecutively from the same roll. Use this rule as a guide when partial width sheets of retroreflective sheeting are used.
      a. Non-conformance may result in non-uniform shading and an undesirable contrast between adjacent widths of applied sheeting which will render signs unacceptable.
      b. Provide a uniform color, brilliance, texture, and general appearance as seen in the daytime and under typical automobile illumination at night for the entire background of each sign.
      c. Use no more sections of retroreflective sheeting than is necessary for backgrounds.
         i. Remnants, scraps, and odd sized pieces of sheeting are not permitted for use in the fabrication of any signs.
      d. Either butt or overlap no more than 3/8 inch, joints between retroreflective sheeting. Horizontal joints between retroreflective sheeting sections are not permitted.

B. Sign Panel Erection:
   1. Slip-sheet, pack, and ship signs in such manner as to ensure arrival at their respective places of erection in an undamaged condition.
   2. All signs arriving at the erection site(s) in a condition which in the opinion of the Engineer, renders them unsuitable for use, are to be removed and replaced by the Contractor at his sole expense.
   3. Do not ship sign panels for erection in such a manner that results in horizontal joints of the retroreflective sheeting.
   4. It is not anticipated that there will be any sign panels which are required to be mounted whose messages will be inappropriate to the guiding of traffic at the time of sign erection. However, in the event that the Engineer determines that certain sign messages are inappropriate, cover the panels of such signs with an opaque material, until such time as the sign messages become appropriate.
      a. Provide a covering Material and manner of securing the Material to the sign panel(s) that meets with the approval of the Engineer.
      b. The Engineer will indicate to the Contractor which signs, if any, must be covered, and when to remove the covers.
   5. Included with the sign panel will be connections to supports, other attaching hardware, and other incidentals as shown or described in the Contract Documents.
   6. Furnish and place identification tags or decals which state the Contract number, month and year of erection on the lower reverse side of the panel, near the point closest to the roadway shoulder.
   7. Erect the sign panel using approved methods of erection.
   8. Attached the sign panel to the sign Structure as required by the Plans and the approved shop drawings.

C. Sign Panel Overlay Installation:
   1. Verify all panel overlay sizes in the field before fabrication of the overlays. Such field verification is considered as an incidental expense to this Item.
   2. Attach any logo to the sign panel overlay as specified on the Plans and as directed by the Engineer.

3. Install sign panel overlay to the specified existing sign as directed by the Plans.
4. Use rivets to attach the sign panel overlay to the existing sign.

818.04 Method of Measurement.

The quantity of sign panels will be measured as the actual number of square feet of front sign face surface area of all sign panels constructed and accepted. The area will be computed from the maximum width and height dimensions of each sign panel, as shown on the Plans, or on the approved sign panel shop drawings, (verified by field measurements). All sign panels will be considered either square or rectangular in shape, as the case may be, and no area deductions will be made for rounding of corners.

818.05 Basis of Payment.

The quantity of sign panel will be paid for at the Contract Unit Price per square foot. Price and payment will constitute full compensation for furnishing and fabricating sign panels complete in place and accepted, with retroreflective Materials, copy, symbols, borders, and connections to supports where necessary, and for all labor, Materials, tools, Equipment, and incidentals required to complete the Item.

If required by the Contract Documents, the cost of removing and transporting existing sign panels and accessories to the DelDOT Sign Shop is included under this Section unless otherwise indicated on the Plans.

ITEM	DESCRIPTION	UNIT
818001	SUPPLY OF FLAT SHEET ALUMINUM SIGN PANEL, TYPE IV RETROREFLECTIVE SHEETING	SF
818002	SUPPLY OF FLAT SHEET ALUMINUM SIGN PANEL, TYPE IX RETROREFLECTIVE SHEETING	SF
818003	SUPPLY OF FLAT SHEET ALUMINUM SIGN PANEL, TYPE XI RETROREFLECTIVE SHEETING	SF
818004	SUPPLY OF EXTRUDED ALUMINUM SIGN PANEL, TYPE IV RETROREFLECTIVE SHEETING	SF
818005	SUPPLY OF EXTRUDED ALUMINUM SIGN PANEL, TYPE IX RETROREFLECTIVE SHEETING	SF
818006	SUPPLY OF EXTRUDED ALUMINUM SIGN PANEL, TYPE XI RETROREFLECTIVE SHEETING	SF

SECTION 819 – SIGN POSTS

819.01 Description.

Furnish, install and remove sign posts and install or remove traffic signs on single or multiple sign posts, including any and all bolts, nuts, baseposts, and hardware, in accordance with the Contract Documents and as directed by the Engineer.

The Items referred to as "Telescoping" are complete units inclusive of one specified length 2 inch sign post, one 36 inch x 2-1/4 inch basepost, one 18 inch x 2-1/2 inch basepost, one corner bolt and one nut. The remaining Items are to be ordered individually to be used as replacement parts.

819.02 Materials.

Provide Materials as specified in:

Sign Post	Section 1072

819.03 Construction.

A. Traffic Signs

1. Unless otherwise indicated in the Contract Documents, the Department will provide all sign Materials to be used on the Project, including signs, posts and associated hardware.
    a. Provide the Department's Sign Shop Supervisor with Project Plans and quantity sheets and provide documentation to the Engineer that the signs have been ordered.
    b. Sign fabrication orders require a minimum of four (4) weeks for completion.
        i. Orders placed with less than four (4) weeks lead-time will result in a delay. Any delay caused by inadequate lead-time due to a late order will be the sole responsibility of the Contractor.
    c. Pick up the completed signs, sign posts, hardware and extensions from the DelDOT Sign Shop and deliver them to the job site without any damage to the sign Materials.
    d. Fabricate and supply signs required to be supplied by the Contractor, as indicated in the Contract Documents, in accordance with Section 818.

B. Traffic Sign Installation

1. Obtain necessary utility clearances before installing sign posts.
2. Install sign post at the location depicted in the Contract Documents.
    a. Place sign post such that the lateral dimension from the edge of the sign closest to traffic is placed in accordance with the DE MUTCD.
    b. Install telescoping steel sign supports as follows:
        i. Install sign post, baseposts, corner bolt and associated hardware in accordance with the Standard Construction Details.
        ii. For signs mounted in an existing concrete island where no hole is provided, core a 4 inch diameter hole for each sign post at the proper location in the concrete island and then place post within the cored hole.
    c. Install wood sign posts as shown in the Standard Construction Details.
3. Install sign onto sign post using supplied hardware.
    a. Mount sign at the appropriate height as specified in the DE MUTCD.
    b. With the exception of YIELD signs, mount a single sign totaling more than nine (9) square feet or with any dimension (length or width) greater than 48 inches on two (2) posts.

c. Mount signs with a dimension (length or width) greater than or equal to 78 inches on three (3) sign posts.

d. Reposition signs and posts that are not installed in accordance with the DE MUTCD or installed in the incorrect location at no additional cost to the Department.

C. Traffic Sign Removal

1. Remove the sign and sign post from the location depicted in the Contract Documents.

a. Completely remove the post including the post extension in the ground.

b. Do not cut posts flush with the ground.

c. Dispose of signs and posts that are not required to be re-installed.

2. Remove all nuts, bolts and other connections between the signs and the posts.

3. Backfill and grade the disturbed ground as directed by the Engineer.

819.04 Method of Measurement.

A. The quantity of telescoping steel sign posts will be measured as the number of each size furnished and accepted, if a note in the Contract Documents requires the Contractor to supply sign posts. Otherwise, the quantity of telescoping steel sign posts will not be measured.

B. The quantity of wood sign posts will be measured as the number of each size furnished, installed, complete in place and accepted.

C. The quantity of holes bored into existing concrete islands will be measured as the number of holes of specified depth installed, complete in place and accepted.

D. Installation or removal of traffic signs will be measured as:

1. The actual number of each sign installed on a single post or removed from a single post for signs less than or equal to nine (9) square feet or with any dimension (length or width) less than or equal to 48 inches.

2. The total square footage of each sign installed on two or more posts or removed from two or more posts for a single sign totaling more than nine (9) square feet or with any dimension (length or width) greater than 48 inches, with the exception of YIELD signs.

819.05 Basis of Payment.

A. If required by a note in the Contract Documents, the quantity of telescoping steel sign post will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for furnishing and delivering all Materials, including the steel sign post, basepost, post extensions, corner bolt and nut and for all labor, tools, Equipment and incidentals necessary to complete the Work in the Items listed below as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
819001	GALVANIZED STEEL SIGN POST ONLY, 9’ X 2”	EA
819002	GALVANIZED STEEL SIGN POST ONLY, 10’ X 2”	EA
819003	GALVANIZED STEEL SIGN POST ONLY, 11’ X 2”	EA
819004	GALVANIZED STEEL SIGN POST ONLY, 12’ X 2”	EA
819005	GALVANIZED BASEPOST SECTION ONLY, 36” X 2.25”	EA
819006	GALVANIZED BASEPOST SECTION ONLY, 18” X 2.25”	EA
819007	UNC CORNER BOLT, GRADE 5, .3125”, COMPLETE WITH NUT	EA
819008	GALVANIZED TELESCOPING STEEL SIGN POSTS, 9’X2”, COMPLETE	EA

ITEM	DESCRIPTION	UNIT
	W/BASEPOSTS & HARDWARE	
819009	GALVANIZED TELESCOPING STEEL SIGN POSTS, 10'X2", COMPLETE W/BASEPOSTS & HARDWARE	EA
819010	GALVANIZED TELESCOPING STEEL SIGN POSTS, 11'X2", COMPLETE W/BASEPOSTS & HARDWARE	EA
819011	GALVANIZED TELESCOPING STEEL SIGN POSTS, 12'X2", COMPLETE W/BASEPOSTS & HARDWARE	EA

B. The quantity of wood sign posts will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for furnishing wooden sign post, preparing wood sign post for breakaway requirements, excavation of holes, installation of post, backfilling and restoring the disturbed area around the post and for all labor, tools, Equipment and incidentals necessary to complete the Work in the Items listed below as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
819012	WOODEN SIGN POSTS, 4" X 4"	EA
819013	WOODEN SIGN POSTS, 4" X 6"	EA
819014	WOODEN SIGN POSTS, 6" X 6"	EA
819015	WOODEN SIGN POSTS, 6" X 8"	EA

C. The quantity of holes bored into existing concrete islands will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for boring holes at the required depth and for all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
819016	INSTALLATION OF 4" DIAMETER HOLE, LESS THAN OR EQUAL TO 6" DEPTH	EA
819017	INSTALLATION OF 4" DIAMETER HOLE, GREATER THAN 6" DEPTH	EA

D. The quantity of sign installations or removals will be paid at the Contract Unit Price as specified in the table below. Price and payment constitute full compensation for installing or removing signs and sign Materials, pickup and delivery of sign Materials, grading disturbed areas, and for all labor, Equipment, tools, and incidentals required to complete the Work as specified and as directed by the Engineer. Move and correct signs that are not installed in accordance with the DE MUTCD or signs installed in incorrect locations at no additional cost to the Department.

ITEM	DESCRIPTION	UNIT
819018	INSTALLATION OR REMOVAL OF TRAFFIC SIGN(S) ON SINGLE SIGN POST	EA
819019	INSTALLATION OR REMOVAL OF TRAFFIC SIGNS ON MULTIPLE SIGN POSTS	SF
819020	REMOVAL OF GROUND MOUNTED WOOD POST	EA

SECTION 820 – BREAKAWAY I-BEAM SIGNS

820.01 Description.

Furnish, install, and/or remove all Materials for a breakaway I-beam sign support in accordance with Contract Documents, and as directed by the Engineer.

820.02 Materials.

Provide Materials as specified in:

Steel I-Beams	Section 615; Section 1039
Breakaway Couplings	Section 1072.03
Brackets	Section 1072.03
Hinge Plates	Section 1072.03
Nuts, bolts, and cap screws	Section 1072.03
Concrete	Section 1022
Reinforcement	Section 1037
Anchor Bolts	Section 1072.03
Borrow	Section 1001

820.03 Construction.

A. Reinforced Concrete Masonry Sign Foundation:

1. Construct foundations in conformance to the dimensions and details indicated in the Contract Documents.
2. Excavation for the foundation may not exceed the dimension of the foundation by more than 1 foot in any one direction. If a form is used in the excavation more than 18 inches below the ground surface, it is necessary that the excavation be filled and tamped on all sides in layers not to exceed 8 inches.
3. Place and secure bar reinforcement before placing concrete.
4. Set anchor bolts to template for alignment and elevation and secure in position to prevent displacement while concrete is being placed.
5. Place concrete in accordance with Section 610.
6. Backfill foundation in accordance with Section 207, dispose of remaining excavated Material and properly grade the area around the foundation.
7. After grading, return the area around the foundation to its original condition with mulching, seeding or other landscaping as necessary or as directed by the Engineer.

B. Breakaway I-Beam Sign Posts:

1. Submit Working Drawings in accordance with Section 105.04 of the Standard Specifications.
   a. Supply detailed, written instructions and drawings for the erection of all sign Structure components.
2. Load, transport, unload and erect structural Materials so that the metal will be kept clean and free from damage in handling.
3. Store structural Materials above the ground on platforms, skid or other supports and keep free from accumulation of foreign matter.
4. Straighten structural Material which has been deformed before Material is laid out, punched, drilled or

otherwise worked upon in the shop. Sharp kinks or bends will be cause for rejection.

5. Repair galvanized areas that were damaged during shipping or by any of the three methods specified under ASTM A780. In all cases, achieve the minimum coating thickness specified for the repair.
6. Prevent Material from being dropped, thrown or dragged over the ground.
7. Install I-beams in a manner as not to damage the base on which the I-beam is to be installed and take care to not interfere with overhead utility lines.
8. Install couplings, bolts and sign mounts as required by the manufacturer's specifications and the Contract Documents.

C. Repair of Existing I-Beam Sign Supports

1. Remove broken couplings and bolts on existing I-beams and remove broken anchor bolts in existing concrete foundation.
2. Reuse existing I-beam supports as required by the Engineer. Furnish and install new couplings, bolts, hinge plates and anchor bolts as required to fully re-install I-beam support. Install I-beam supports in accordance with Section 820.03.B.
3. Replace damaged concrete base in accordance with 820.03.A as directed by the Engineer.

D. Removal of Existing I-Beam Sign Supports

1. Remove sign and I-Beam supports as required by the Contract Documents using methods approved by the Engineer.
2. All removed Material becomes the property of the Contractor to dispose of accordingly.

E. Install or remove sign panel on I-Beam sign support

1. Install sign panel on I-beam sign support in accordance with the Contract Documents and manufacturer recommendations.
2. Remove existing sign panel from I-beam support in accordance with the Contract Documents and manufacturer recommendations.

820.04 Method of Measurement.

A. Reinforced Concrete Masonry Sign Foundation: Measure the quantity of reinforced concrete masonry sign foundations as the actual number of foundations for the specified size of beam constructed in accordance with the Contract Documents, complete in place, and accepted.

B. Breakaway I-Beam Sign Posts: Measure the quantity of breakaway I-beam sign posts furnished as the number of linear feet for the length and size of breakaway I-beam sign posts furnished as specified and accepted.

C. Breakaway Coupling System: Measure the quantity of breakaway coupling systems, bolt kits and hinge plates as the actual number of devices furnished and assembled as specified, complete in place, and accepted.

D. Installation or Removal of Breakaway I-Beam Sign Mounts: Measure the quantity of breakaway I-beam sign mounts installed or removed as the actual number of sign mounts installed or removed, complete in place and accepted.

E. Installation or Removal of Sign Panel on Breakaway I-Beam Support: Measure the quantity of sign panel installed or removed as the actual number of square feet of front sign face surface area of all sign panels installed, complete in place and accepted.

820.05 Basis of Payment.

A. Reinforced Concrete Masonry Sign Foundation: The quantity of reinforced concrete masonry sign foundations will be paid at the Contract Unit Price per each. Price and payment constitute full

compensation for furnishing all Materials, constructing sign foundation, furnishing and setting anchor bolts, returning the area around the sign foundation to its original condition, and for all labor, Equipment, tools, and incidentals required to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
820001	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-6	EA
820002	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-8	EA
820003	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-10	EA
820004	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-12	EA
820005	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-14	EA
820006	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-18	EA

B. Breakaway I-Beam Sign Posts: The quantity of breakaway I-beam sign posts will be paid at the Contract Unit Price per linear feet. Price and payment constitute full compensation for furnishing breakaway I-beam sign posts of the length and size specified in the Contract Documents, furnishing and assembling breakaway coupling systems, bolt kits and hinge plates, nuts, bolts and cap screws and all other Materials for the breakaway assemblies, delivery of the Material to the Project location and for all labor, Equipment, tools and incidentals necessary to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
820007	SUPPLY OF BREAKAWAY I-BEAM SIGN POSTS, W-4	LF
820008	SUPPLY OF BREAKAWAY I-BEAM SIGN POSTS, W-6	LF
820009	SUPPLY OF BREAKAWAY I-BEAM SIGN POSTS, W-8	LF
820010	SUPPLY OF BREAKAWAY I-BEAM SIGN POSTS, W-10	LF
820011	SUPPLY OF BREAKAWAY I-BEAM SIGN POSTS, W-12	LF
820012	SUPPLY OF BREAKAWAY I-BEAM SIGN POSTS, W-14	LF
820013	SUPPLY OF BREAKAWAY I-BEAM SIGN POSTS, W-18	LF

C. Breakaway Coupling System: The quantity of breakaway coupling systems, bolt kits and hinge plates will be paid at the Contract Unit Price per each. Price and payment constitute furnishing hinge plates, breakaway couplings, nuts, bolts and cap screws and all other Materials for the breakaway assemblies in accordance with the Contract Documents; assembly of breakaway coupling system and for all labor, Equipment, tools and incidentals necessary to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
820014	SUPPLY & INSTALLATION OF BOLT KIT FOR BREAKAWAY COUPLING	EA
820015	SUPPLY & INSTALLATION OF HINGE PLATE FOR BREAKAWAY COUPLING	EA
820016	SUPPLY & INSTALLATION OF BREAKAWAY COUPLING SYSTEM	EA

D. Installation or Removal of Breakaway I-Beam Sign Mounts: The quantity of breakaway I-beam sign mounts installed or removed will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for installation or removal of sign mounts and for all labor, Equipment, tools, and incidentals required to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
820017	INSTALLATION OF BREAKAWAY I-BEAM SIGN POSTS	EA

820018	REMOVAL OF BREAKAWAY I-BEAM SIGN POSTS	EA

E. Installation or Removal of Sign Panel on Breakaway I-Beam Sign Support: The quantity of sign panels on breakaway I-beam sign supports installed or removed will be paid at the Contract Unit Price per square foot. Price and payment constitute full compensation for installation or removal of sign panel and for all labor, Equipment, tools, and incidentals required to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
820019	INSTALL SIGN PANEL ON BREAKAWAY I-BEAM SIGN SUPPORT	SF
820020	REMOVE SIGN PANEL ON BREAKAWAY I-BEAM SIGN SUPPORT	SF

SECTION 821 – BARRIER-MOUNTED SIGNS

821.01 Description.

Furnish, install, and/or remove concrete barrier-mounted sign supports and sign panels in accordance with the Contract Documents and as directed by the Engineer.

821.02 Materials.

Provide Materials as specified in:

Steel Tubing	Section 1039
Hardware (Bolts, Nuts, Washers)	Section 1039
Anchor Bolts	Section 1039
Sign Panels	Section 818

821.03 Construction.

A. Supply and install 2 inch or 4 inch square tube posts, base plates, and associated hardware for barrier mounted sign supports in accordance with the Contract Documents.

B. Install Barrier-Mounted Sign Supports and I-Beams:

1. Install barrier mounted sign supports in accordance with the Standard Construction Details.
2. Load, transport, unload and erect structural Materials such that the metal will be kept clean and free from damage in handling.
3. Store structural Materials above the ground upon platforms, skid or other supports and keep free from accumulation of dirt, oil, acids or other foreign matter.
4. Detail all assemblies and members to permit hot-dip galvanizing. Complete all cutting, punching, drilling, finishing, and welding prior to hot-dip galvanizing.
5. Repair galvanized areas damaged during shipping or erection by any of the three methods specified under ASTM A780.
    a. In all cases, achieve the minimum coating thickness specified for the repair. However, the repair of galvanized items having one or more damaged areas larger than 1 square inch will not be allowed.
6. Install sign panel on sign support as required by the Contract Documents.

C. Remove Barrier Mounted Sign Supports and I-Beams

1. Remove sign from sign support or I-beam without damaging sign.
2. Remove sign supports and mounting hardware from barrier.
3. Plug remaining holes in barrier with an approved non-shrink grout.

821.04 Method of Measurement.

A. The quantity of concrete barrier-mounted sign supports and I-beams furnished and installed will be measured as the actual number of sign supports furnished and installed as specified and accepted.

B. The quantity of concrete barrier-mounted sign supports and I-beams removed will be measured as the actual number of sign supports removed.

C. The quantity of sign panels installed or removed on concrete barrier-mounted sign supports will be measured as the actual number of square feet of sign panel installed or removed as specified and accepted.

821.05 Basis of Payment.

A. The quantity of concrete barrier-mounted sign supports and I-beams installed will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for furnishing and installing all Materials for the sign support in accordance with the Contract Documents and for all labor, Equipment, tools and incidentals necessary to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
821001	SUPPLY OF BARRIER MOUNTED SIGN SUPPORT, 4” POST	EA
821002	SUPPLY OF BARRIER MOUNTED SIGN SUPPORT, 2” POST	EA
821003	INSTALLATION OF BARRIER MOUNTED SIGN SUPPORT	EA

B. The quantity of concrete barrier-mounted sign supports and I-Beams removed will be paid at the Contract Unit Price per each. Price and payment will constitute full compensation for removing all Materials for the sign support in accordance with the Contract Documents and for all labor, Equipment, tools and incidentals necessary to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
821004	REMOVAL OF BARRIER MOUNTED SIGN SUPPORT	EA

C. The quantity of sign panels installed or removed on concrete barrier-mounted sign supports will be paid at the Contract Unit Price per square foot. Price and payment will constitute full compensation for installing or removing sign panels in accordance with the Contract Documents and for all labor, Equipment, tools and incidentals necessary to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
821005	INSTALLATION OF SIGN ON BARRIER MOUNTED SIGN SUPPORT	SF
821006	REMOVAL OF SIGN ON BARRIER MOUNTED SIGN SUPPORT	SF

SECTION 822 – OVERHEAD AND CANTILEVER SIGN PANELS

822.01 Description.

Install, reposition, or remove a sign panel on an overhead or cantilever Structure in accordance with the Contract Documents and as directed by the Engineer.

822.02 Materials.

Connections	Section 615 and Section 1039
Vertical Support Members	Section 615 and Section 1039
Sign Panels	Section 818

A. The Contractor or the Department supplies the signs to be installed as indicated in the Contract Documents.

1. If signs are supplied by the Department, request fabrication of signs in accordance with Section 818.
2. The signs may be supplied with pre-drilled holes for use in mounting the sign.

822.03 Construction.

822.03.1 Submittals.

Design support members and connections to the support members for the sign panels in accordance with the latest editions of the FHWA Standard Highway Signs and Markings manual, Delaware (DE) MUTCD, and AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

Submit Working Drawings in accordance with Section 105.04 as required per Contract Documents, for the support members, and connections to the support members, of the sign panels.

Submit design calculations in accordance with the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, signed and sealed by a registered Professional Engineer in the State of Delaware.

822.03.2 Operations

A. Installation of overhead and cantilever sign panel:

1. Take care to prevent any damage to the sign panel or sign Structure.
2. Sign installation may require the sign to be assembled in sections.
    a. Assembly of sign panels is covered in Section 818.
3. Install sign panels to the height specified in the Contract Documents; the height is to be measured from the bottom of the sign panel to top of the pavement wearing course.
4. Install sign panels and connect to overhead or cantilever structure as shown in the Contract Documents.

B. Repositioning of an existing sign panel:

1. Remove the existing sign from the supporting Structure and reinstall it at the new location on the same Structure.
2. The horizontal location of the sign on the supporting Structure will be determined by the Engineer.
3. Replace damaged or otherwise unsuitable connections at the direction of the Engineer.
4. Re-install the existing sign at the new location in accordance with Section 822.03.2.A.

C. Removal of an existing sign panel from a Structure:

1. Take care to prevent any damage to the sign panel, sign Structure, or any electrical wire or lights attached to the sign panel.

2. If lights are attached to the sign panel, disconnect the wiring prior to removing the sign panel.
3. Remove the wiring that powers the lights at the direction of the Engineer.
4. Remove the sign panel and connecting hardware.
5. Sign Materials removed which are not identified for re-use become the Contractor's responsibility for disposal.

822.04 Method of Measurement.

The quantity of signs installed on overhead and cantilever Structures will be measured as the number of square feet of complete signs installed in accordance with the Contract Documents, complete, in place, and accepted.

The quantity of signs repositioned on overhead and cantilever Structures will be measured as the number of square feet of signs repositioned in accordance with the Contract Documents, complete, in place and accepted.

The quantity of signs removed from overhead and cantilever Structures will be measured as the number of square feet of signs removed.

822.05 Basis of Payment.

The quantity of overhead and cantilever signs installed will be paid at the Contract Unit Price per square foot. Price and payment will constitute full compensation for installing sign panels, preparing and placing all Materials, and for all labor, Equipment, tools and incidentals necessary to complete the Work as specified by the Engineer.

The quantity of overhead and cantilever signs repositioned will be paid at the Contract Unit Price per square foot. Price and payment will constitute full compensation for detachment of sign from existing Structure, re-installation at new location on Structure, preparing and placing all Materials, and for all labor, Equipment, tools and incidentals necessary to complete the Work as specified by the Engineer. Supply, installation, relocation, removal and cutting of I-beam backing supports will be paid separately under the respective Pay Items listed below.

The quantity of overhead and cantilever signs removed will be paid at the Contract Unit Price per square foot. Price and payment constitute full compensation for removal of existing overhead sign, removal of overhead sign lighting, and for all labor, Equipment, tools and incidentals necessary to complete the Work as specified by the Engineer. Removal of wiring for sign lighting will be paid under the applicable Pay Item of Section 832.

ITEM	DESCRIPTION	UNIT
822001	INSTALL SIGN PANEL OVERLAY	SF
822002	INSTALLATION OF SIGN ON/OVER HIGHWAY STRUCTURE	SF
822003	REPOSITION EXISTING SIGN ON OVERHEAD STRUCTURE	SF
822004	SUPPLY OF OVERHEAD I-BEAM, W-6	LF
822005	INSTALLATION OF OVERHEAD I-BEAM	EA
822006	RELOCATION OF OVERHEAD I-BEAM	EA
822007	CUTTING OF OVERHEAD I-BEAM	EA
822008	REMOVAL OF OVERHEAD I-BEAM	EA
822009	REMOVAL OF SIGN ON/OVER HIGHWAY STRUCTURE	SF

SECTION 823 – SPAN WIRE/MAST ARM SIGN PANELS

823.01 Description.

Install, reposition, or remove a sign on a span wire or mast arm in accordance with the Contract Documents and as directed by the Engineer.

823.02 Materials.

Provide Materials as specified in:

Sign Panels	Section 818
U-bolts, nuts and washers	Section 1039

A. Span wire clamps, if span wire mounting is required.

1. Dual face span wire clamps to hold street name signs and other span wire mounted signs.
2. Submit catalog cut to Engineer for approval prior to installation.

B. Mast arm bracket, if mast arm or pole mounting of sign is required.

1. Single face mast arm/pole mount sign hardware.
2. Dual face mast arm/street name sign hardware.
3. Submit catalog cut to Engineer for approval prior to installation.

C. Fabricate connections of industry standard Material. Connections must be approved by the Engineer.

823.03 Construction Methods.

A. Mast Arm Installation

1. Install mast arm bracket and associated hardware as specified by the manufacturer at the location specified in the Contract Documents.
2. Attach sign to bracket in accordance with bracket manufacturer recommendations.
3. Install the sign a minimum height of 17 feet above the ground, measured from the pavement to the bottom of the sign.
4. Take care to prevent any damage to the sign panel or mast arm during installation.

B. Span Wire Installation

1. Install span wire clamp and associated hardware as specified by the manufacturer at the location specified in the Contract Documents.
2. Attach sign to the span wire clamp in accordance with manufacturer recommendations.
3. Install the sign a minimum height of 17 feet above the ground, measured from the pavement to the bottom of the sign.
4. Take care to prevent any damage to the sign panel, span wire or any electrical cable attached to the span wire during installation process.

C. Reposition existing sign on span wire or mast arm

1. Remove the existing sign and mounting hardware from the supporting Structure and reinstall it at the new location as specified in the Contract Documents.
2. The Engineer will determine the horizontal location of the sign on the supporting Structure.
3. Replace mounting hardware at the discretion of the Engineer.

D. Removal of existing sign on span wire or mast arm

1. Remove existing sign and mounting hardware from mast arm or span wire as specified by the Contract Documents.
2. Take care to prevent any damage to the sign panel, span wire, mast arm, or any electrical cable attached to the span wire during removal process.
3. Sign Materials removed which are not identified for re-use become the Contractor's responsibility for disposal.

823.04 Method of Measurement.

Installation of sign on span wire or mast arm will be measured as the number of square feet of complete signs installed, complete, in place, and accepted.

Repositioning of existing sign on span wire or mast arm will be measured as the actual number of span wire or mast arm signs repositioned and accepted.

Removal of existing sign on span wire or mast arm will be measured as the actual number of span wire or mast arm mounted signs removed.

823.05 Basis of Payment.

The quantity of span wire or mast arm mounted signs installed will be paid at the Contract Unit Price per square foot of sign installed. Price and payment constitutes full compensation for all labor, Equipment, tools, and incidentals required to complete the Work as specified by the Engineer.

The quantity for repositioning span wire or mast arm mounted signs will be paid at the Contract Unit Price per each. Price and payment constitutes full compensation for furnishing, preparing and placing all Materials including new hardware, and for all labor, Equipment, tools and incidentals required to complete the Work as specified by the Engineer.

The quantity of span wire or mast arm mounted signs removed will be paid at the Contract Unit Price per each. Price and payment constitutes full compensation for sign and hardware removal, and for all labor, Equipment, tools and incidentals required to complete the Work as specified by the Engineer.

ITEM	DESCRIPTION	UNIT
823001	INSTALLATION OF SIGN ON SPAN WIRE OR MAST ARM	SF
823002	REPOSITION SIGN ON SPAN WIRE OR MAST ARM	EA
823003	REMOVAL OF SIGN ON SPAN WIRE OR MAST ARM	EA

SECTION 824 – DELINEATORS

824.01 Description.

Furnish, install, relocate, and maintain high performance flexible plastic, post-mounted delineation devices or barrier mounted reflectors in accordance with the Contract Documents and as directed by the Engineer.

824.02 Materials.

Provide Materials as specified in:

Delineators	Section 1073

824.03 Construction.

A. High Performance Flexible Plastic Delineators

1. Furnish high performance flexible plastic delineators that meet the requirements of the Delaware Manual on Uniform Traffic Control Devices (DE MUTCD) and as stated in the Contract Documents.
2. Install delineators on asphalt or concrete surfaces as specified by the manufacturer of the delineators.
    a. The method of installation must provide for easy replacement of damaged delineators.
3. Replace damaged delineators within 24 hours of notification by the Engineer.

B. Post-Mounted Delineators

1. Samples
    a. Submit for approval two samples each of the posts, brackets, connecting devices, and driving heads complete with reflector units.
    b. Do not ship Materials to the construction site until samples have been submitted and are approved by the Engineer in writing.
    c. Samples must include steel posts and each color of delineator to be used.
2. Special Keys and Wrenches
    a. Whenever special keys, wrenches, or special locking instruments are required for the removal, placing, maintenance and repair for any of the component parts of the delineators furnish and deliver to the Engineer one of each type for each 500 delineators or portion thereof.
3. Install post mounted delineators in accordance with the manufacturer’s requirements and as directed by the Engineer.
4. Replace damaged delineators within 24 hours of notification by the Engineer.

C. Barrier Mounted Delineators

1. Install high impact barrier mounted delineators onto permanent P.C.C. barrier
    a. Longitudinally space the delineators as specified in the DE MUTCD.
    b. Install delineator at a height of 29 inches, measured from the roadway surface to the top of the delineator.
    c. Attach delineator to the traffic side of the P.C.C. barrier wall face as specified by manufacturer using approved adhesive Material or mechanical fasteners.
2. Replace damaged delineators within 24 hours of notification by the Engineer.

824.03 Method of Measurement.

The quantity of the delineators will be measured as the actual number of delineators for the respective Item, installed, complete-in-place and accepted.

824.04 Basis of Payment.

The quantity of delineators will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for furnishing, installing, and maintaining and replacing delineators; and for all labor, tools, Equipment, and necessary incidentals to complete the Work as specified and as directed by the Engineer.

A. Payment for replacement of each damaged delineator will be made at the Contract Unit Bid Price for the appropriate pay Item after the quantity replaced is verified by the Engineer.

B. Delineators damaged by the Contractor during execution of Work will be replaced at no cost to the Department.

ITEM	DESCRIPTION	UNIT
824001	BARRIER MOUNTED DELINEATOR	EA
824002	POST MOUNTED DELINEATORS	EA
824003	FLEXIBLE DELINEATOR, PERMANENT	EA

SECTION 825 – FLEXIBLE TUBULAR MARKERS, PERMANENT

825.01 Description.

Furnish and install tubular markers at the locations specified in the Contract Documents in accordance with these Specifications, the Delaware Manual on Uniform Traffic Control Devices (DE MUTCD) and as directed by the Engineer.

825.02 Materials.

A. Furnish tubular markers meeting the following requirements:

1. Predominantly orange unless otherwise specified in the Contract Documents or directed by the Engineer.
2. 28 inches high and 2 inches in diameter.
3. Constructed of a Material that can be struck without causing damage to the impacting vehicle.
4. Provide retroreflectorized sheeting as required by the DE MUTCD.

825.03 Construction.

A. Remove all loose debris from the road surface and make sure the road surface is dry.

B. Anchor the tubular marker to the pavement using a method that is approved by the product manufacturer.

825.04 Method of Measurement.

The quantity of flexible tubular markers will be measured as the actual number of tubular markers installed, complete-in-place and accepted.

825.05 Basis of Payment.

The quantity of tubular markers installed will be paid at the Contract Unit Price per each. Price and payment constitutes full compensation for all labor, Equipment, tools, Materials, and incidentals required to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
825001	TUBULAR MARKERS	EA

SECTION 826 – PERMANENT WOOD BARRICADE

826.01 Description.

Furnish all Materials, construct and place pressure treated wood barricades at the locations shown in the Contract Documents and as directed by the Engineer.

826.02 Materials.

Provide Materials as specified in:

Wood	Section 621; Section 1041
Sign Panels	Section 818
Hardware, Galvanized	Section 1039

826.03 Construction.

A. Fabricate the permanent barricade using yellow pine or fir, No. 1 common, Surfaced Four Sides (S4S), in accordance with the Delaware Manual for Uniform Traffic Control Devices (DE MUTCD) and the Contract Documents.

B. Treat all sides, bottoms, and tops of the wood posts and rails with a preservative treatment in accordance with Section 1041 of the Standard Specifications.

C. Install retroreflective sheeting and sign panels, minimum sheet panel thickness 1/8 inches, for the object markers in accordance with the DE MUTCD and Contract Documents.

D. Excavate ground for posts.

E. Place posts into the excavated holes in accordance with the Contract Documents.

F. Backfill as necessary and dispose of unneeded Material in accordance with Section 106.08.

G. Grade area as required by the Engineer.

826.04 Method of Measurement.

The quantity of permanent wood barricades will be measured as the actual number of permanent wood barricades constructed, placed, and accepted.

Sign panels for the permanent wood barricade and object markers will not be measured and are incidental to this Item.

826.05 Basis of Payment.

The quantity of permanent wood barricades will be paid at the Contract Unit Price per each. Price and payment constitutes full compensation for furnishing and installing all Materials, including hardware, reflective sheeting, sheet aluminum sign panels, preservative treatment, excavation and backfilling, and for all labor, Equipment, tools, and incidentals necessary to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
826001	PERMANENT WOOD BARRICADE	EA

SECTION 830 – CONDUIT JUNCTION WELLS

830.01 Description.

Furnish, construct, install, adjust, relocate and remove conduit junction wells and spare frames and lids or precast polymer concrete covers in accordance with the Contract Documents and as directed by the Engineer.

830.02 Materials. Provide Materials as specified in the following:

A. Conduit Junction Well, Types 1, 4, 5

1. Precast Concrete
    a. Concrete, Class B, Section 1022
2. Del. Stone No. 57, Section 1004
3. Castings, Section 1039
4. Frames, Section 602
5. Lids, Section 602
    a. Provide logo on cover
        i. “DOT-E” (Types 1, 4 and 5)

B. Conduit Junction Well, Type 7

1. Precast polymer concrete stackable box with no base.
2. Del. Stone No. 57 Section 1004
3. Precast Polymer Concrete
    a. Reinforced by heavy-weave fiberglass
        i. Compressive strength of 9,000 – 15,000 pounds per square inch
        ii. Impact energy of 30-72 foot pounds
        iii. Tensile strength of 800 – 1,100 pounds per square inch
            A) Tested in accordance with ASTM D543, Section 7, Procedure 1 for chemical resistance
4. Precast Polymer Concrete Cover
    a. Heavy-duty type with a design load of 15,000 pounds over a 10 inch square.
    b. Coefficient of friction greater than 0.5
    c. Provide logo on cover
        i. “DelDOT TRAFFIC FIBER OPTICS”

C. Conduit Junction Well, Types 11, 14, 15

1. Precast Concrete
    a. Concrete, Class B, Section 1022
2. Del. Stone No. 57, Section 1004
3. Precast Polymer Concrete Cover
    a. Heavy-duty type with a design load of 15,000 pounds over a 10 inch square.
    b. Coefficient of friction greater than 0.5

c. Provide logo on cover

i. "DelDOT ELECTRIC"

D. Borrow in accordance with Section 1001.

830.03 Construction.

A. Conduit Junction Well

1. Excavate to the required depth in accordance with Section 207.03. Construct a stone base for the junction well. Compact the foundation, upon which the junction well is to be placed, to a firm, even surface to the acceptance of the Engineer.

2. Provide conduit junction well conforming to the Contract Documents, or the manufacturer's specifications. More than one conduit may extend into the well.

3. Set conduit junction well.

4. Set cast iron frame and lid or polymer concrete box cover.

a. Set cast iron frame and lid or polymer concrete box cover level with the surrounding surface when constructed within pavement, sidewalks, etc.

b. Set cast iron frame and lid or polymer concrete box and cover above grade and graded to drain away from the junction well in conformance with the Contract Documents when constructed in unpaved areas.

5. Backfill the area around the well with Borrow Type C Material to the required elevation in accordance with Section 207 and dispose of excess or unsuitable material per Section 106.08.

6. Ground and bond junction well in accordance with Section 833.

B. Adjust or Repair Existing Conduit Junction Well

1. Repair of conduit junction wells includes repairing/patching the masonry walls and replacing damaged or missing frames and lids or precast polymer concrete covers.

2. Adjusting includes raising the elevation of the frame and lid to match the grade of the surrounding area.

3. Keep silt and debris away from the Structure until Work is complete.

C. Relocation of Existing Junction Well

1. Relocate existing junction well(s) to clear utilities or other construction Work as specified in the Contract Documents.

2. Relocate junction well in a manner that will not damage the junction well, frame and lid or precast polymer concrete cover.

3. Expose the conduit that is connected to the junction well, and needs to be moved with the junction well, for a distance necessary to move the junction well. Use caution so as to not place excessive stress on the conduit or its couplings.

4. Backfill and tamp entire Work area, in accordance with Section 207, where the junction well and conduits are relocated. The Engineer will not measure or pay for any extra fill needed to complete the backfill.

D. Removal of Existing Junction Well

1. Remove existing junction well as specified in the Contract Documents.

2. Remove existing junction well in a manner that will not damage the junction well, frame and lid, or precast polymer concrete cover.

3. Abandon and cap, or connect together, any conduits that enter into the junction well as directed by the Engineer and in accordance with the Contract Documents.

4. Backfill with Type C borrow or as directed by the Engineer, in accordance with Section 207.

   a. Grade area to drain.

   b. Place 6 inch minimum lift of top soil.

   c. Seed in accordance with Section 908.

E. Spare Junction Well Frame and Lid or Precast Polymer Concrete Cover

1. Supply, deliver, pick-up, or remove spare cast iron frames and lids or precast polymer concrete covers for new and existing junction wells as required by the Contract Documents.

2. Install spare frame and lid or precast polymer concrete cover on junction well as directed by the Engineer.

830.04 Method of Measurement.

A. Conduit Junction Well

1. All types

   a. The quantity of junction wells will be the actual number of conduit junction wells by type, which are supplied, constructed, complete, in place and accepted, including frames and lids or precast polymer concrete covers and stone base.

   b. Install frames and lids or precast polymer concrete covers prior to acceptance.

B. Adjust or Repair Existing Conduit Junction Well

1. The quantity of conduit junction wells adjusted or repaired will be measured as the actual number of conduit junction wells adjusted or repaired and accepted.

   a. If a new frame and lid or precast polymer concrete cover is needed, it will supplied under a separate pay Item.

C. Relocation of Existing Junction Well

1. The quantity of conduit junction wells relocated will be measured as the actual number of conduit junction wells relocated complete, in place and accepted.

D. Removal of Existing Junction Well

1. The quantity of conduit junction wells removed will be measured as the actual number of conduit junction wells removed.

   a. Excavation around existing junction wells to be removed, backfill Material, and backfilling of the area where the junction well was removed are incidental to the Bid Item.

E. Spare Junction Well Frame and Lid or Precast Polymer Concrete Cover

1. The quantity of spare frames and lids or precast polymer concrete covers will be measured as the actual number of frames and lids or precast polymer concrete covers by type supplied, delivered to the Department or Project site and accepted.

830.05 Basis of Payment.

A. The quantity of conduit junction wells installed, complete, in place and accepted will be paid at the Contract Unit Price per each. Price and payment constitutes full compensation for furnishing, installation, excavation, backfilling, and installing the stone base, grounding and bonding new junction well, and for all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer. Payment for conduit extending into the junction well will be paid under Section 831.

ITEM	DESCRIPTION	UNIT

ITEM	DESCRIPTION	UNIT
830001	CONDUIT JUNCTION WELL, TYPE 1, 20" X 20" PRECAST CONCRETE	EACH
830002	CONDUIT JUNCTION WELL, TYPE 4, 20" X 42 ½" PRECAST CONCRETE	EACH
830003	CONDUIT JUNCTION WELL, TYPE 5, 24" X 16" PRECAST CONCRETE	EACH
830004	CONDUIT JUNCTION WELL, TYPE 7, 36" X 60" PRECAST POLYMER CONCRETE	EACH
830005	CONDUIT JUNCTION WELL, TYPE 11, PRECAST CONCRETE/POLYMER LID-FRAME	EACH
830006	CONDUIT JUNCTION WELL, TYPE 14, PRECAST CONCRETE/POLYMER LID-FRAME	EACH
830007	CONDUIT JUNCTION WELL, TYPE 15, PRECAST CONCRETE/POLYMER LID-FRAME	EACH

B. The quantity of existing conduit junction wells adjusted or repaired will be paid at the Contract Unit Price per each. Price and payment constitutes full compensations for adjustment of existing junction well, repair of existing junction well and for all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
830008	ADJUST OR REPAIR EXISTING CONDUIT JUNCTION WELL	EACH

C. The quantity of existing conduit junction wells relocated or removed will be paid at the Contract Unit Price per each. Price and payment constitutes full compensation or relocation of existing junction well, removal of existing junction well, excavating, backfilling, lateral adjustment of existing conduits and for all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer. Existing conduit and cables that need to be removed or installed will be paid under Sections 831 and Section 832, respectively.

ITEM	DESCRIPTION	UNIT
830009	RELOCATION OF EXISTING JUNCTION WELL	EACH
830010	REMOVAL OF EXISTING JUNCTION WELL	EACH

D. The quantity of spare junction well frames and lids or precast polymer concrete covers furnished and installed will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for furnishing spare frame and lid or precast polymer concrete cover, delivery to the Department or Project site and installation as required by the Engineer and for all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
830011	FURNISH & INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 1	EACH
830012	FURNISH & INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 4	EACH
830013	FURNISH & INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 5	EACH
830014	FURNISH & INSTALL PRECAST POLYMER COVER FOR JUNCTION WELL, TYPE 6	EACH
830015	FURNISH & INSTALL PRECAST POLYMER COVER FOR JUNCTION WELL, TYPE 7	EACH
830016	FURNISH & INSTALL PRECAST POLYMER COVER FOR JUNCTION WELL, TYPE 8	EACH

830017	FURNISH & INSTALL PRECAST POLYMER COVER FOR JUNCTION WELL, TYPE 9	EACH
830018	FURNISH & INSTALL PRECAST POLYMER COVER FOR JUNCTION WELL, TYPE 10	EACH
830019	FURNISH & INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 11	EACH
830020	FURNISH & INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 14	EACH
830021	FURNISH & INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 15	EACH

SECTION 831 – CONDUIT

831.01 Description.

Furnish, install and remove conduit (metallic and non-metallic) in accordance with the Contract Documents and as directed by the Engineer.

831.02 Materials.

Provide Materials as specified in:

Conduit and Conduit Hangers	Section 1062
Pulling Rope	Section 1062
Warning / Location Tape	Section 1062
Conduit / Duct Sealant	Section 1062

831.03 Construction.

When possible, install conduit in a straight line between terminal points. For fiber optic conduit, provide junction well spacing of no greater than 600 feet. For traffic signal and lighting conduit, provide junction well spacing of no greater than 250 feet. Use sweeping bends for any bends that are required during installation of conduit. Consult the Engineer prior to installing any bends to ensure that the proper arc is provided.

For exposed ends of lighting conduit in pole bases, cabinet bases, junction wells and risers, apply conduit/duct sealant as directed by the Engineer. Sealant must provide a liquid tight connection to prevent water, oil and rodent entry into the conduit system. Do not use sealant for traffic signal or fiber optic conduit.

Provide minimum cover, as measured from the finished grade, of 24 inches and a maximum cover, as measured from the finish grade, of 48 inches.

If not already pre-installed by the manufacturer, install a pulling rope or tape (fish wire) in each conduit for future use. The pulling rope may be eliminated when the cable is installed immediately.

For conduit not terminated to a base or junction well, use typical termination methods as required by the Standard Construction Details. Do not extend conduit into a junction well any more than 3 inches.

Place sealed end caps (with knockouts if empty) on the ends of all conduits after compressed air has been used to clear all foreign matter

831.03.1 Galvanized Steel Conduit.

Furnish up to 4 inch nominal diameter galvanized steel conduit meeting the Material requirements of Section 1062 and as specified in the Contract Documents. Using conduit tools; cut, ream and thread galvanized steel conduit. Provide an appropriate length of thread to ensure that the sections of conduits, when screwed into a coupling and tightened correctly, will butt together and the joint will be watertight. Use an approved three-piece threaded union to join two threaded lengths of galvanized steel conduit in the case where a standard coupling will not work. Do not use a threaded union in a conduit run that is to be driven. Do not use a threadless coupling or a split-bolt coupling for direct buried conduit.

831.03.2 HDPE-SDR 13.5 Conduit.

Furnish up to 4 inch nominal diameter HDPE conduit meeting the Material requirements of Section 1062 and as specified in the Contract Documents. Connect lengths of HDPE conduit with irreversible fusion couplings. Mechanical and removable couplings will not be accepted.

831.03.3 PVC Schedule 80 Conduit.

Furnish up to 4 inch nominal diameter PVC conduit meeting the Material requirements of Section 1062 and as specified in the Contract Documents. Using conduit tools, cut and prepare the conduit. Connect all lengths of PVC conduit by inserting the normal end of one length of conduit into the flared end of the adjoining length of conduit. If

this is not possible, then a coupling may be used. Seal all joints with appropriate epoxy to ensure that the two conduit pieces bond to one another to form a solid waterproof link. If approved by the Engineer, a coupler module may be used where conduit segments do not align properly to allow the flared end of one conduit segment to mate with the normal end of the other segment. Place sealed end caps on the ends of all conduits after compressed air has been used to clear all foreign matter.

831.03.4 Flexible Metallic-Liquid Tight Conduit.

Furnish up to 3 inch nominal diameter flexible metallic-liquid tight conduit meeting the Material requirements of Section 1062 and as specified in the Contract Documents.

831.03.5 Nonmetallic Pole Riser Shield.

Furnish up to 4 inch nominal diameter nonmetallic pole riser shield with belled meeting the Material requirements of Section 1062 and as specified in the Contract Documents.

831.03.6 Directional Bore Installation.

Use the directional bore method when specified in the Plans for installation of conduits with a diameter no less than 1-1/2 inches under existing pavement. Provide a directional bore that does not exceed the outside diameter of the conduit being installed by more than 1 inch. In cases where the directional bore exceeds the outside diameter by more than 1 inch, pump cement grout into the void.

Upon completion of the directional boring operation and installation of the conduit, uncover the forward end of the conduit and use compressed air to clear all foreign matter before inspection. Repair any existing conduit that is disturbed during installation.

831.03.7 Open Cut Installation.

Use the open cut installation method when specified in the Plans for installation of conduits with a diameter no less than 1-1/2 inches under existing pavement. If not specified in the Plans, the Engineer must approve all open cutting of roadways. The Contractor is responsible for the removal of all cut pavement and the replacement and repair of any damaged pavement once the conduit is installed.

Saw cut pavement in accordance with Section 762 and remove and dispose of cut pavement in accordance with Section 402 or Section 503, for bituminous or rigid pavements respectively. Remove pavement to a width no less than 18 inches and no more than 24 inches. Excavate the trench and stockpile Material for use in backfilling the trench. Stockpiled Material will be deemed suitable or unsuitable for re-use by the Engineer. If deemed unsuitable, discard and furnish and install new backfill Material at no additional cost to the Department. Excavate to a depth in accordance with Section 831.03 and the Contract Documents. Install conduit in trench and terminate into a junction well or base in accordance with the Standard Construction Details.

Backfill trench with approved fill Material. Backfill the trench in maximum 8 inch lifts, compacting the Material in accordance with Section 207 between lifts. Install underground warning tape over the conduit at a depth of approximately 12 inches below the final grade. Use additional lifts of Material as required to install the warning tape at the specified depth and compact the final lift of fill Material to achieve the desired final grade. Patch open trench in accordance with Section 402 for bituminous pavements or Section 503 for rigid pavements.

831.03.8 Unpaved Trench Installation.

Excavate trench where conduit is to be installed. Excavate the trench and stockpile Material for later use in backfilling the trench. Excavate to a depth in accordance with Section 831.03 and the Contract Documents. Install conduit in trench and terminate into a junction well or base in accordance with the Standard Construction Details.

Backfill trench with approved fill Material. Fill the trench in maximum 8 inch lifts, compacting the Material in accordance with Section 207 between lifts. Install underground warning tape over the conduit at a depth of approximately 12 inches below the final grade. Use additional lifts of Material as required to install the warning tape at the specified depth. Tamp the final lift of fill Material to achieve the desired final grade. Topsoil and seed disturbed area in accordance with the appropriate sections of the Standard Specification.

831.03.9 Installation of Conduit on Structure.

Install conduit on Structure, as specified in the Contract Documents, using approved conduit hangers and approved anchors. Drill anchors into concrete, brick, stone, steel, or wood and attach the conduit hangers, spaced not more than 36 inches apart. Use appropriate sweeping bends to provide any necessary 90-degree turns in the conduit run.

831.03.10 Pole Riser Shield.

Install nonmetallic pole riser shield on wood poles in accordance with the Contract Documents and in a straight vertical line. If the nonmetallic pole riser is not the same size as the conduit to which it attaches, use an adapter at no additional cost to the Department. Attach the nonmetallic pole riser shield to the wood pole with 1/4 inch x 1-1/2 inch galvanized lag bolts with washers. Install lag bolts at a spacing no more than 36 inches apart on both sides of the nonmetallic pole riser shield and in the top most and bottom most set of slots.

831.03.11 Removal of Conduit from Wood Pole.

Remove galvanized, aluminum, PVC or HDPE conduit or nonmetallic pole riser shield from wood pole. Remove the conduit and all straps, nails and/or lag screws in a manner so as to not damage or disturb the pole or surrounding conduits. Dispose of all Materials in accordance with Section 106.08.

831.04 Method of Measurement.

A. Conduits, all types: The quantity of galvanized steel, HDPE, PVC or flexible metallic liquid tight conduit and nonmetallic pole riser shield will be measured as the number of linear feet of conduit and nonmetallic pole riser shield furnished, installed as specified, complete in place and accepted.

   1. Measure length of conduit installed under existing pavement by directional bore along the path of the bore from the point that cannot be trenched to a point that trenching can resume.

   2. Measure length of conduit installed in open cut pavement, unpaved trench, on wood pole and on a Structure along the conduit.

B. Removal of conduit from wood pole: Measure the quantity of conduit removed from a wood pole as the number of linear feet of conduit completely removed in an acceptable manner.

831.05 Basis of Payment.

A. The quantity of conduit furnished and installed will be paid at the Contract Unit Price per linear foot for the Pay Items listed below. Price and payment constitutes full compensation for furnishing conduit, installing conduit under the method specified by the Contract Documents, and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer. Borrow Material furnished to backfill trenches will be paid under Section 209. Topsoil and seeding will be paid under the appropriate Sections of the Standard Specification. Restoration of pavement will be paid under the appropriate Sections of the Standard Specification.

ITEM	DESCRIPTION	UNIT
831001	FURNISH & INSTALL UP TO 3” FLEXIBLE METALLIC-LIQUID TIGHT CONDUIT	LF
831002	FURNISH & INSTALL UP TO 4” SCHEDULE 80 HDPE CONDUIT (BORE)	LF
831003	FURNISH & INSTALL UP TO 4” SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831004	FURNISH & INSTALL UP TO 4” SCHEDULE 80 PVC CONDUIT (TRENCH)	LF
831005	FURNISH & INSTALL UP TO 4” SCHEDULE 80 PVC CONDUIT (ON STRUCTURE)	LF
831006	FURNISH & INSTALL UP TO 4” GALVANIZED STEEL CONDUIT (TRENCH)	LF
831007	FURNISH & INSTALL UP TO 4” GALVANIZED STEEL CONDUIT (BORE)	LF
831008	FURNISH & INSTALL UP TO 4” GALVANIZED STEEL CONDUIT (OPEN CUT)	LF
831009	FURNISH & INSTALL UP TO 4’ GALVANIZED STEEL CONDUIT (ON STRUCTURE)	LF
831010	FURNISH & INSTALL UP TO 4” NONMETALLIC POLE RISER SHIELD	LF

B. The quantity of conduit removed from wood poles will be paid at the Contract Unit Price per linear foot for the Pay Items listed below. Price and payment constitutes full compensation for removal of conduits and associated attachment hardware, disposal of removed Material and for all labor, tools, Equipment and incidentals required to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
831011	REMOVAL OF CONDUIT FROM WOOD POLE	LF

SECTION 832 – ELECTRIC CABLE AND SPLICING

832.01 Description.

Furnish, install, splice (if approved) and remove electrical cable in conduit, in accordance with the Contract Documents and as directed by the Engineer.

832.02 Materials.

Provide Materials as specified in:

Electrical Cable / Wire	Section 1074
Copper Conductor Cable	Section 1074
Cable Splicing	Section 1074
Breakaway Connector Kits, Submersible	Section 1074

832.03 Construction.

A. General

1. Transport and unreel electric cable from a cable trailer.
    a. Do not lay reels on the ground to remove wire or cable.
2. Avoid damaging cable insulation when removing cable from drums or reels, or during installation of the cable.
3. Remove and replace all unacceptable cable with new cable using the specified methods at no cost to the Department.

B. Pulling cable or wire through conduit, mast arms, traffic poles, lighting poles, existing conduit, etc.

1. Obtain written approval from the Engineer before using any power-assisted methods of pulling communications or electrical cable or wire into conduit.
2. Hand pulling methods
    a. Required for conduit sizes of 1-1/2 inches or less
    b. Preferred for all other sizes.
3. Dynamometer is recommended for use when pulling cable or wire other than by hand.
4. Use a short piece of material that will part if the strain exceeds the amount specified below between the pulling grip and the pulling medium, unless otherwise directed by the Engineer:
    a. 150 pounds for all pulls up through 12 pair communications cable
    b. 300 pounds for all larger cables
5. The Engineer may deem a cable or wire unacceptable if:
    a. Pulled into any conduit without the use of an acceptable pulling grip.
    b. Pulled into a conduit without the use of a strain release element.
    c. Pulled using methods which may have or did result in pulling forces in excess of strain release material.
    d. Pulled using methods which may have or did result in pulling forces in excess of those set forth herein or as directed by the Engineer.

6. Install cable or wire in existing conduit by pulling through the conduits.
    a. Use pull lubricant of the type recommended by the cable manufacturer, if required by the Engineer.
    b. Prepare cable or wire for pulling by reeling them from their respective reels as they enter the conduit or by taking sufficient length from the reel to comprise the set to be pulled.
    c. To avoid damaging insulation and to eliminate any twists or kinks, marry the cables in a straight lay.
    d. Do not allow entry of moisture into the cable at any time during installation.
    e. Seal cable ends using rubber tape and paint with a sealing type of waterproof compound until final splices are made.
7. Hand feed cables into the conduit.
8. Use sleeve when additional radius is required to prevent damage to the cable or wire.
    a. No additional payment will be made for sleeves or their use.
9. Start underground cable runs at one terminal point and continue without splices to the final terminal point except for “Home Run Cable” to “Loop Detector Wire”.
    a. Do not splice Opticom cable in any application.
10. Leave and arrange additional cable and wire in a neat and orderly manner as noted:
    a. Leave 6 feet of copper cable supported on cable rack assemblies, when pulled through junction wells.
    b. Leave 6 feet of cable neatly arranged and laced with cable ties, at the control box and other splice locations.
11. Ensure that the placement of a fish does not damage or entangle the existing cable or wire, when cable already exists in a conduit.
    a. Provide the lead end of a fish containing a blunt terminal.
12. Do not bend or tape the end of the fish or leave termination with rough edges or any sort of hook that might engage an existing wire or cable when the fish is extracted.
13. Draw cable in together and keep the cable parallel to each other by means of a pulling head, when two or more wires are to occupy the same conduit.
14. Arrange phase legs circumferentially and in sequence around the neutral wires.
15. For Lighting Cables, leave 2 feet of slack in lighting transformer base.
16. For Lighting Cables, duct seal all conduit ends after cable installations using means and methods described in Section 831 - Conduit.
    a. Traffic signal conduits are not provided with duct sealant.

C. Overhead (on Span Wire)

1. Do not splice the electrical cable at the top of the pole but have the electrical cable continue onto the span wire to be taped.
2. Orient the electrical cable so that water will not run along its length and run into the steel pole.
3. Install the electrical cable on the underside of the span wire with no crossover or wraps around the span wire.
4. Wrap the electrical cable at least six times around the span wire every twelve to fourteen inches.
5. Pull the electrical cable tight without any kinks.

6. Wrap the jacket (plastic) tape tight around the span wire.
7. Make a 36 inch long loop of signal cable at each signal head.

D. Splicing

1. Traffic Control Cable and Single Conductor Stranded Wire

a. Underground traffic control cable splices (except between loop detector wire and "home-run" cable) or splices in between conduit runs are prohibited.

b. Traffic signal cables are only spliced above ground in pole hand-holes, transformer bases or on span wire at the signal head.

c. Carefully seal the end of each section of cable in the control box and at all splice locations, using rubber tape, and painted with a sealing type of waterproof compound, after cables have been installed and pending permanent splicing.

d. Identify the circuit number of all cables and wires with color coded tape attached to each of the cables and wires in the control box and at all splice locations.

e. Secure the color coded tape to the cable or wire with nylon cable ties.

f. Re-install any splices found to be faulty within 90 days of installation, at no extra expense to the Department.

g. Remove the insulation from each conductor to be spliced, to expose ½ inch of copper.

h. Use of any tool or method which might damage the conductor is prohibited.

i. Inspect and trim each conductor not being spliced so that the conductor does not extend beyond the insulation.

j. Connect each conductor to be spliced, then return all conductors (both used and unused) to their original configuration before the insulation was removed and then sealed as specified.

k. Do not allow individual cables to extend beyond the splice of the last signal head for each signal phase.

l. Do not splice Shielded Opticom cable.

m. Splice Shielded Aluminum Cable ("Home-Run cable") only with the loop detector wire in a junction well. Do not splice the "home-run cable" outside of this junction well.

n. Overhead

i. Place conductors to be electrically connected side by side with the exposed copper aligned.

ii. Twist the copper clockwise with pliers until a good mechanical connection is affected.

iii. Install and hand tighten a proper size wire nut.

iv. If necessary to cover all the copper, minor trimming may be done.

v. The copper splice is 5/16 inch long when trimmed.

vi. Ensure that no insulation is caught up in the copper area of the splice.

vii. Ensure that the splice is kept dry by taking care during the taping and placement of the completed splice to prevent water from entering the splice between or around the cables.

o. Termination of cable (Butt Splice)

i. Remove the sheath of each cable as necessary.

ii. Prepare the splice for taping when all conductors to be joined have been completed.

iii. Place the cables in a butt position and position all wires and wire nuts to ensure that no shorts

exist and that the splice area is reduced to as small a diameter as possible.

iv. Begin taping with rubber tape two inches over the intact sheath.

v. Wrap the tape around the splice proceeding toward the other cable overlapping half of the tape width until a point two inches on the other cable sheath has been reached.

vi. Repeat taping in the other direction starting one tape width wider than the previous wrap.

vii. Increase overlapping where necessary to cover all areas of the splice.

viii. Provide rubber tape at least four layers (two fully overlapped passes) deep for every area of the splice.

ix. Cover the rubber tape with plastic tape applied in the same fashion.

p. Taps or Tee Splices

i. Remove the sheath of the through cable a distance of 8 inches centered on the point of splice.

ii. Remove the sheath of the branch cable a distance of 4 inches.

iii. Separate out and cut the through cable conductors which are to be joined to the conductors of the branch cable(s) from the others.

iv. Do not cut any other conductors for any purpose.

v. Depending upon the need, the branch cable(s) may be placed beside one of the through cables and the splicing proceed or the through cable may be doubled back so that the parts of the through cable and the branch cable(s) are placed side by side.

vi. Prepare the splice for taping when all conductors to be joined have been completed.

vii. Place the cables in their approximate final position and inspect the cables for shorts.

viii. After all wire nuts and wires are properly positioned, begin taping on the through cable 2 inches from the end of the sheath,

ix. Wrap the tape around the splice proceeding with a 1/2 inch width overlap across the splice area and onto the other through sheath for a distance of 2 inches.

x. Wrap the tape from the endpoint back across the splice to the branch cable(s) and onto the sheath for a distance of one inch.

xi. Wrap the tape back from the end point on the branch cable(s) back to the main cable.

xii. Tape the remaining part of the splice in the same manner.

xiii. Provide rubber tape at least four layers (two fully overlapped passes) deep for every area of the splice.

xiv. Place the cables in their final position and tape with two fully overlapped passes of plastic tape in the in the same fashion.

xv. The plastic tape does not need to cover the interior areas covered by the rubber tape.

xvi. Place the splice so that the branch cable(s) enters the splice from below to prevent water from flowing along the branch cable(s) into the splice area.

q. Termination End of Cable

i. Remove 3 inch of sheath from dead ended cables.

ii. Wrap each individual cable with rubber taped.

iii. Bundle and re-tape with vinyl tape

iv. Coated with waterproofing compound.

r. Triplex Splice

i. Remove sufficient insulation of the triplex service cable and other service cables to expose the conductor.

ii. Connect each of the three wires with a compression connecter, with an approved compression tool in accordance with the manufacturer's installation instructions.

2. Lighting Cable and Single Conductor Stranded Wire

a. H-Tap and C-tap Compression Connectors in junction wells or transformer bases:

i. Installed in transformer bases for "pass-through" cables, Conductors serving luminaire spliced per D.3. below.

ii. Compression type, applied by means of a compression tool.

iii. Compression connector is wrapped in 2 layers of vinyl tape and 2 layers of rubber tape. Tape is "half-lapped" around connector.

3. Submersible, breakaway connector kits in lighting transformer bases:

a. Install connector kits in conformance with the Manufacturer's recommendations.

E. Removal

1. Remove existing cable as specified in Plans.

2. Dispose of removed cable properly.

3. Remove cable in a manner that will not damage any other Equipment.

4. Conduit or Steel Pole

a. Hand pulling methods required for conduit sizes of 1-1/2 inches or less and are preferred for all sizes.

b. Prior written approval by the engineer is required for the use of any power assisted method of pulling wire or cable from conduit.

c. Use a short piece of material that will part if the strain exceeds the amount specified below between the pulling grip and the pulling medium, unless industry standards require less:

i. 600 pounds for non-connectorized outdoor fiber optic cable

ii. 150 pounds for all pulls up through 12 pair communications cable

iii. 300 pounds for all larger cables

d. Any and all electrical wire or cable pulled from any conduit without the use of an acceptable pulling grip, kellems or equal, and without the use of a strain release element or by using methods which may have or did result in pulling forces in excess of those set forth herein or prescribed by industry standards are hereby declared damaged and shall be replaced by the Contractor.

e. For removal from steel pole, only hand pulling methods are permitted.

i. First, remove the weatherhead cover using proper tools.

ii. Remove the wire or cable by hand and replace the weatherhead cover properly.

f. The electrical wire or the number of electrical or communications cable(s) to be pulled from each conduit or steel pole will be as shown on the Plans or as directed by the Engineer.

g. Remove wire or cables from existing conduit or steel pole by pulling the wire or cables through the conduit or steel pole.

h. The number of electrical wires or cables pulled from a conduit may exceed one.

832.04 Method of Measurement.

A. Cable

1. The quantity of cable will be measured as the actual number of linear feet of cable furnished and pulled through conduits (underground, in mast arms, or in poles) or installed on a span wire, complete in place, and accepted.

2. Measure all required cable slack left at termination points or in junction wells as part of this item.

B. Removal

1. Conduit or Traffic/Lighting Pole

a. Measure the quantity of electrical wire or cable as the number of linear feet of electrical wire or cable removed by pulling through a conduit or a steel pole in accordance with these Specifications.

b. When pulling more than one wire, the entire set to be pulled will be considered one cable, even if pulled one at a time.

c. Existing electrical wire or cable being used as a fish wire to pull in new wire or cable is not paid as removal of cable or wire from conduits or poles.

832.05 Basis of Payment.

The quantity of cable furnished and pulled through all conduit (underground, in mast arms, or on poles) or furnished and installed on a span wire will be paid at the Contract Unit Price per linear foot of the applicable pay Item. Price and payment constitutes full compensation for all labor, Equipment, tools, Materials, Material testing, compression connectors, breakaway connector/splice kits, splicing, taping, and incidentals required to complete the Work as specified above and as directed by the Engineer.

The quantity of cable removal from all conduit or traffic/lighting poles will be paid at the Contract Unit Price per linear foot of the applicable pay Item. Price and payment constitutes full compensation for all labor, Equipment, tools, Materials, and incidentals required to complete the Work as specified above and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
832001	FURNISH & INSTALL 1-CONDUCTOR #4/0 AWG STRANDED COPPER, TYPE USE-2	LF
832002	FURNISH & INSTALL 1-CONDUCTOR #3/0 AWG STRANDED COPPER, TYPE USE-2	LF
832003	FURNISH & INSTALL 1-CONDUCTOR #2/0 AWG STRANDED COPPER, TYPE USE-2	LF
832004	FURNISH & INSTALL 1-CONDUCTOR #1/0 AWG STRANDED COPPER, TYPE USE-2	LF
832005	FURNISH & INSTALL 1-CONDUCTOR #1 AWG STRANDED COPPER, TYPE USE-2	LF
832006	FURNISH & INSTALL 1-CONDUCTOR #2 AWG STRANDED COPPER, TYPE USE-2	LF
832007	FURNISH & INSTALL 1-CONDUCTOR #4 AWG STRANDED COPPER, TYPE USE-2	LF
832008	FURNISH & INSTALL 1-CONDUCTOR #6 AWG STRANDED COPPER, TYPE USE-2	LF
832009	FURNISH & INSTALL 1-CONDUCTOR #8 AWG STRANDED COPPER, TYPE USE-2	LF
832010	FURNISH & INSTALL 1-CONDUCTOR #10 AWG STRANDED COPPER, TYPE USE-2	LF
832011	FURNISH & INSTALL 1-CONDUCTOR #10 AWG STRANDED COPPER, TYPE THWN OR THHN	LF
832012	FURNISH & INSTALL 1-CONDUCTOR #12 AWG STRANDED COPPER, TYPE THWN OR THHN	LF
832013	FURNISH & INSTALL 1-CONDUCTOR #14 AWG STRANDED COPPER, TYPE THWN OR THHN	LF

ITEM	DESCRIPTION	UNIT
832014	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#4/0 AWG	LF
832015	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#2/0 AWG	LF
832016	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#1/0 AWG	LF
832017	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#2 AWG	LF
832018	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#4 AWG	LF
832019	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#6 AWG	LF
832020	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#8 AWG	LF
832021	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#10 AWG	LF
832022	FURNISH AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#12 AWG	LF
832023	FURNISH & INSTALL #12 AWG THWN SOLID COPPER	LF
832024	FURNISH & INSTALL #2 AWG BARE SOLID COPPER	LF
832025	FURNISH & INSTALL 4-CONDUCTOR #18 AWG SHIELDED OPTICOM CABLE	LF
832026	FURNISH & INSTALL 1-CONDUCTOR #14 AWG STRANDED COPPER	LF
832027	FURNISH & INSTALL 1-CONDUCTOR #14 AWG SHIELDED CABLE	LF
832028	FURNISH & INSTALL #6 BARE STRANDED COPPER GROUND WIRE	LF
832029	FURNISH & INSTALL #8/2 WIRE UF W/GROUND	LF
832030	FURNISH & INSTALL #8/3 WIRE UF W/GROUND	LF
832031	FURNISH & INSTALL #6 TRIPLEX ALUMINUM SERVICE CABLE	LF
832032	FURNISH & INSTALL 14/4 TRAFFIC CONTROL CABLE	LF
832033	FURNISH & INSTALL 14/9 TRAFFIC CONTROL CABLE	LF
832034	FURNISH & INSTALL 14/16 TRAFFIC CONTROL CABLE	LF
832035	REMOVAL OF CABLE FROM CONDUIT OR TRAFFIC/LIGHTING POLE	LF

SECTION 833 – GROUNDING

833.01 Description.

Furnish and install grounding Equipment in accordance with the Contract Documents and as directed by the Engineer.

833.02 Materials.

Provide Materials specified in:

Hardware (Bolts, Nuts, Washers), Stainless Steel Section 1039

A. Ground Rods

1. Underwriter's Laboratory Approved
2. 3/4 inch in diameter
3. 10 feet long (minimum) unless otherwise specified
4. Copper-clad steel
5. Approved clamps for connecting the grounding conductor to the ground rod

833.03 Construction.

Provide certified test reports verifying the ground resistance of each ground or ground grid when installed.

833.03.1 Ground Rods.

Furnish and install ground rods with a minimum 3/4 inch diameter and 8 feet embedment into undisturbed soil at the locations indicated in the Contract Documents. Measure the ground resistance of each rod before connecting the rod to the grounding conductor. In accordance with the National Electric Code, if the measured resistance exceeds 25 ohms, exothermically weld a 10-foot extension to the top of the first rod and drive to its full depth. Measure the earth resistance again. If it still exceeds 25 ohms, contact the Engineer for direction. Exothermically weld the ground rod and joining ground wire after successful testing. Paint the weld and exposed cable with two coats of insulating varnish.

Where rock is encountered and an acceptable earth ground cannot be accomplished by driving as described above, the Engineer may direct the use of a grounding grid. Direct buried rods are exothermically welded end-to-end to bond lighting standards and Structures in continuous series to a point where an acceptable ground can be obtained.

Maintain continuity of the Equipment grounding system throughout the Project. Make connections to Equipment grounding systems using suitable lugs at all grounding bushings specified and at the ground lugs in lighting or traffic signal Structure access holes or in a breakaway base. Make connections to ground rods as specified in the Contract Documents. Make connections to neutral grounding systems using grounding lugs.

833.03.2 Bonding & Grounding Junction Well.

Drill holes in the junction well cover and in the junction well frame. Attach a braided bonding strap to both the cover and frame in accordance with the Contract Documents to ensure proper bonding. Bond the junction well frame to the existing ground wire in the junction well using a compression connector (example: C-Tap).

833.04 Method of Measurement.

A. Ground Rods: Measure the number of 10 foot long lengths of ground rods installed as the actual number of ground rods furnished, installed as specified, complete in place and accepted. Measurement will only be made for those ground rods furnished, installed and accepted when those ground rods are to be replaced or added as a singular Item. Ground rods installed as part of other Items (Pole Bases, Cabinet Bases or Metered Service Pedestals) will not be measured separately as the ground rod is incidental to these Items.

B. Bonding & Grounding Junction Well: Measure number of existing junction wells properly grounded and bonded. Measurement will not be made for grounding and bonding of new junction wells as grounding and bonding is incidental to the applicable junction well pay Item.

833.05 Basis of Payment.

Price and payment constitutes full compensation for furnishing and installation of Pay Items at the pay unit below and for all labor, tools, Equipment, and necessary incidentals to complete the Work as specified and as directed by the Engineer. No payment will be made for ground rods installed as part of other Items (Pole Bases, Cabinet Bases and Metered Service Pedestals). No payment will be made for grounding and bonding new junction wells.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
833001	BONDING & GROUNDING EXISTING JUNCTION WELL	EA
833002	FURNISH & INSTALL GROUND ROD	EA

SECTION 834 – POLE BASES; EXTENSIONS; AND SHEETING

834.01 Description.

Construct and install concrete pole bases in accordance with Contract Documents and as directed by the Engineer.

834.02 Materials.

Provide Materials as specified in:

A. Pole Base Extension

1.	Concrete, Class B	Section 1022
2.	Bar reinforcement, Grade 60	Section 1037
3.	Ground Rods	Section 833
4.	Conduit Sweeps	Section 1062

B. Pole Base Sheeting

1.	Steel sheet piling	Section 1032
2.	Corrugated round steel tube	As directed by the Engineer
3.	Sono Tube	As directed by the Engineer
4.	Well-point system	Section 906

C. Anchor Bolts Section 1039

834.03 Construction.

834.03.1 Pole Base: Construct pole base of the type specified and at the location noted in the Plans. Excavate pole base location to the appropriate depth for the type of pole base specified in the Plans. In cut (back) slopes, the required depth below finished grade is measured at the front of the pole base. In fill (fore) slopes, the required depth below finished grade is measured at the back of the pole base. Do not exceed the diameter of the type of pole base to be constructed during excavation. Construct pole base in accordance with the Contract Documents, including placement of anchor bolts, bar reinforcement, conduit sweep and ground rod. Diameter and depth of pole base to be as shown in the Standard Construction Details for the type of pole base indicated in the Plans. Cap the ends of the conduit sweeps with a galvanized threaded conduit plug unless the conduit sweeps are connected to existing conduit. After the concrete has cured, backfill disturbed area around the pole base using approved Material. Place and compact backfill Material in accordance with Section 202. Topsoil and seed disturbed area in accordance with the applicable Sections of the Standard Specifications.

834.03.2 Pole Base Extension: Extend pole bases, as directed by the Engineer, where pole bases are required to extend to a depth greater than that shown on the Standard Construction Details. Excavate additional required depth. Extend reinforcing bars in a pattern that complies with the Standard Construction Details and matches the pattern of the pole base being extended using continuous vertical bars in accordance with 611.03.C. Form pole base extension and pour concrete in accordance with Section 610. Backfill excavated area in accordance with Section 202.

Install ground rod in accordance with Section 833. Install ground rod so that it extends 8 inches above the final grade of the pole base.

834.03.3 Pole Base Sheeting: Install steel sheet piling, corrugated round steel tube, sonotube and/or well-point system when soil conditions are encountered that prohibit the construction of a pole base by using wood or plywood sheeting. Install pole base sheeting as directed by the Engineer.

Construct pole base as specified in 834.03.1 after installation of pole base sheeting. Extend the two conduit sweeps specified for pole bases a minimum of 12 inches beyond the wall of the sheeting. Cap the ends of the conduit sweeps with a galvanized threaded conduit plug unless the conduit sweeps are connected to existing conduit. Leave

all sheeting Material in place and cutoff sheeting Material at least six inches below the surface of the ground. Dispose of excavated Material from the Project site in accordance with Section 106.08.

834.04 Method of Measurement.

834.04.1 Pole Base: Measure the quantity of pole base as the actual number of pole base of the type specified in the Contract Documents installed, complete in place and accepted.

834.04.2 Pole Base Extension: Measure the quantity of pole base extension as the number of cubic feet of concrete required to increase the vertical dimension from the standard depth to the increased depth. The volume will be measured by multiplying the vertical increase in depth by the cross-sectional area of the standard pole base.

834.04.3 Pole Base Sheeting: Measure the quantity of pole base sheeting as each unit of sheeting for pole base furnished, installed and accepted. Payment will only be made for those locations where the Contractor has written permission to use sheeting.

834.05 Basis of Payment.

Payment will be made for the accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
834001	POLE BASE, TYPE 3	EACH
834002	POLE BASE, TYPE 3A	EACH
834003	POLE BASE, TYPE 3B	EACH
834004	POLE BASE, TYPE 3C	EACH
834005	POLE BASE, TYPE 4	EACH
834006	POLE BASE, TYPE 6	EA
834007	POLE BASE EXTENSION	CF
834008	SHEETING FOR POLE BASE	EA

834.05.1 Pole Base: The quantity of pole base will be paid at the Contract Unit Price per each for the pole base type specified in the Contract Documents. Price and payment constitutes full compensation for furnishing and placing all Materials including concrete, bar reinforcement, ground rod as required, anchor bolts, conduit sweeps, excavation and backfilling; and for all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer.

834.05.2 Pole Base Extension: The quantity of pole base extensions will be paid at the Contract Unit Price per cubic feet for pole base extension. Price and payment constitutes full compensation for furnishing and placing all Materials including concrete, bar reinforcement, ground rod as required, excavation and backfilling; and for all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer.

834.05.3 Pole Base Sheeting: The quantity of pole base sheeting will be paid at the Contract Unit Price per each. Price and payment constitutes full compensation for furnishing and placing all Material including cutting off sheeting and removal from the Project site as described, for all labor, tools, Equipment and any incidentals necessary to complete this Item as specified and as directed by the Engineer.

SECTION 835 – CABINET BASES

835.01 Description

Construct the type of cabinet base as specified in the Contract Documents and as directed by the Engineer.

835.02 Materials

Provide Materials as specified in:

Portland Cement Concrete, Class B	Section 1022
Del. Stone No. 57	Section 1004
Ground Rods & Clamps	Section 833
Hex Bolts, Stainless Steel	Section 1039
Conduit Sweeps, PVC Schedule XX	Section 1062
Drop-in Anchors, Zinc plated or stainless steel	Section 1039

1. Manufactured by Hilti Systems, Concrete Fastening Systems or approved equal

835.03 Construction.

Construct cabinet base in accordance with the Contract Documents. Excavate the area for the Cabinet Base. Do not exceed the dimension of the foundation by more than 12 inches in any one direction. Where a cabinet base is to be placed in existing concrete pavement or sidewalk, saw cut the concrete in a square pattern or remove the concrete to the nearest joint. Repair any damage to the existing pavement at the Contractor's expense and meeting the approval of the Engineer. Removal or replacement of any type of pavement under this Item is incidental to the cost of the Item. Stockpile all excavated Material on the site until backfilling has been completed. Construct a stone base for the cabinet base in conformance with the Standard Construction Details. If the base is being installed in an unpaved area, excavate additional space for the required concrete apron and place stone in the extended area. Set ground rod as shown in the applicable Standard Construction Detail and in accordance with Section 833. A minimum of 8 foot of the ground rods must be driven into undisturbed soil through a 2 inch PVC sleeve.

Set conduit sweeps as shown in the Contract Documents. Drive the PVC sleeve into the ground so that the top of the sleeve is 2 inches above the concrete when the base is poured. Place forms to the full depth for the base and install conduit sweeps as shown in the Standard Construction Details. Use conduit sweeps with 90 degree elbows and with 24 inch radii and a min of 2 inch with a max of 4 inches of conduit to be exposed above finished pad grade. Connect conduit sweeps to the existing conduit as shown on Plans. Cap all conduit sweeps. Tape is not approved for use to cap conduits. Mark the location of the conduit on the base with arrows drawn in the wet concrete within 6 inches of outer edge.

Pour concrete for Cabinet Base and any required concrete aprons. Set drop-in anchor. Level, edge and give the base a broom finish Cure concrete for two days prior to removal of forms and conduit plugs. Backfill around the cabinet base and dispose of unsuitable Material. Fill and tamp the area between the form and excavated area on all sides.

835.04 Method of Measurement.

The quantity of Cabinet Bases will be measured as the number of bases constructed, complete in place and accepted. Payment for all conduits extending into the cabinet base is included in the Items for installation of conduit.

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835.05 Basis of Payment.

The accepted quantities of Cabinet Bases constructed, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
835001	CABINET BASE TYPE F	EA
835002	CABINET BASE TYPE M	EA
835003	CABINET BASE TYPE P	EA
835004	CABINET BASE TYPE R	EA

Price and payment constitutes full compensation for all concrete, ground rods, conduit sweeps, labor, Equipment, tools, Materials, and incidentals required to complete the Work as specified and as directed by the Engineer.

SECTION 836 – TRAFFIC SIGNAL POLES AND MAST ARMS

836.01 Description.

Install, relocate and remove the specified Department furnished type of steel pole, pedestal pole and mast arm assembly on an existing pole base in accordance with the Contract Documents and as directed by the Engineer.

836.02 Materials.

Unless otherwise indicated in the Contract Documents, steel mast arm, steel pole and pedestal pole and all necessary hardware will be furnished by the Department.

Where pole installation is part of the Work of relocating an existing pole on a Project, the pole and related hardware will be that which is removed from the existing pole site.

836.03 Construction.

836.03.1 Installation.

Unless otherwise indicated in the Contract Documents, the Department will provide all traffic signal poles and mast arms to be used on the Project, including associated hardware. To obtain the Materials from the Department, notify the Engineer two Working Days prior to picking up the pole(s) and other related hardware. Materials can be picked up at the Dover Sign Shop, 14 Sign Shop Road, Dover, DE 19903.

Assemble steel poles and mast arms. Prior to erecting a pole, ensure that there is a sufficient length of anchor bolt to permit the anchor bolt to be at least flush, but not more than two threads above the top of the top nut when tightened in place. If this condition does not exist, notify the Engineer and await instructions. Do not erect the pole until directed.

Identify all aerial utilities within the area and coordinate the Work with the owner of the Utility. Install poles at least 10 feet under and 10 feet away from primary electric facilities.

Remove all conduit caps or knockouts from the conduit that extend from the pole base. Install insulated grounding bushings. Install a #6 AWG copper ground wire between the 3/4-inch ground rod clamp and the insulated grounding bushing and attach to the lug or stud in the metal pole or pedestal. On multi-section steel camera poles, continue the #6 AWG copper ground wire to the top of the upper section of the pole from the insulated grounding bushing to a bonding lug attached to the camera mounting bolts. Do not install or temporarily place the #6 AWG copper ground wire between the leveling nut and the pole.

Raise steel pole or pedestal pole into position by a suitable hoisting device. Ensure that the hoisting device is rated for the weight and reach necessary. Place pole on the anchor bolts. Hold pole in place until the nuts have been installed and tightened on the anchor bolts in accordance with the Contract Documents. Use a nut under the base of the pole and a nut above the base of the pole on all steel pole installations. Adjust and tighten the anchor bolt nuts once the pole is set, to properly position and cant the pole in accordance with the Contract Documents. Connect the ground wire. For pedestal poles, place the shroud/skirt installation around the pole in accordance with the manufacturer's instructions. For installation of mast arms, install arm to pole in accordance with the mast arm manufacturer's requirements. Form and grout the area between the base of the pole/pole skirt and the top of the foundation as indicated in the Contract Documents. Place the anchor bolt covers and hand whole cover on the pole. Place caps at the top of the poles and at the ends of the mast arms.

836.03.2 Removal.

Disconnect all electrical Equipment from pole. Detach and remove all Equipment from the pole. Stabilize pole and remove top nuts. Use a suitable hoisting device to remove the pole. Ensure that the hoisting device is rated for the weight and reach necessary. Remove the pole with related hardware assemblies carefully from the pole base. Store pole and related hardware within the Project limits for transportation later to a new or reused pole base. If the pole base is to be reused, clean the grout or other Materials off the top of the pole base. Cap the conduit using a conduit plug to prevent entry of any water or Materials. Do not use tape as a method of capping a conduit. If the pole base is not immediately reused, adjust or protect the pole base to prevent injury to pedestrians.

836.03 Method of Measurement.

The quantity of poles installed will be measured as the number of poles installed as specified, complete and accepted.

The quantity of poles removed will be measured as the number of poles removed as specified.

836.04 Basis of Payment.

The quantity of poles installed will be paid at the Contract Unit Price per each pole. Price and payment constitutes full compensation for transporting and setting the poles, all Materials and for all labor, tools, Equipment, and incidentals necessary to complete the Item and as directed by the Engineer.

The quantity of poles removed will be paid for at the Contract Unit Price per each pole. Price and payment includes full compensation for removing and transporting the pole with hardware and pedestal, and for all labor, Equipment, tools, and necessary incidentals to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
836001	INSTALLATION OF STEEL POLE (EQUAL TO OR GREATER THAN 17 FEET AND LESS THAN 40 FEET)	EACH
836002	INSTALLATION OF STEEL POLE (EQUAL TO OR GREATER THAN 40 FEET)	EACH
836003	INSTALLATION OF PEDESTAL POLE	EACH
836004	REMOVE STEEL POLE (EQUAL TO OR GREATER THAN 17 FEET AND LESS THAN 40 FEET)	EACH
836005	REMOVE STEEL POLE (EQUAL TO OR GREATER THAN 40 FEET)	EACH
836006	REMOVE PEDESTAL POLE	EACH
836007	INSTALLATION OF STEEL MAST ARM POLE WITH SINGLE OR TWIN MAST ARMS UP TO 70 FEET	EACH

SECTION 837 – TRAFFIC SIGNAL INDICATIONS

837.01 Description.

Furnish, assemble and install light emitting diode (LED) traffic signal indications, pedestrian signal indications housings, pedestrian pushbuttons and associated hardware either as separate components on an existing signal installation or as new components to be installed as a rigid or span mount or as a top or side mount on a steel or wood pole in accordance with the Contract Documents and as directed by the Engineer.

837.01.1 Referenced Documents.

This Specification refers to definitions and practices described in the following Institute of Transportation Engineers (ITE) documents:

A. "Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement" (dated June 27, 2005), referred to in this document as "VTCSH-LED."

B. "Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Vehicular Arrow Traffic Signal Supplement" (dated January 2008), referred to in this document as "VTCSH-ARROW."

C. "Equipment and Material Standards of the Institute of Transportation Engineers (dated November 1998), referred to in this document as "VTCSH"

837.02 Materials.

Provide Materials as specified in:

Traffic Signal Heads	Section 1075

837.03 Construction.

837.03.1 Furnish & Install Signal Head Section, Rigid Mount.

Furnish, assemble and install rigid mounted LED signal heads, housings and visors in the configurations shown in the Contract Documents. Complete wiring and electrical connections to make the signal head fully functional. Provide a minimum of a six section, twelve position terminal block capable of accepting three number 14 AWG spade terminal ends for each single and/or double section and the middle section of a three section signal head assembly. Rigid mount signal assemblies will generally be mounted on steel poles, but may be mounted on wood poles for temporary signal installations. Refer to the Contract Documents for the various mounting types including top, side and rigid. All such mounts are considered as "Rigid Mounts" for payment purposes. Place signal cable (paid for under separate Contract Pay Items) down the pole and into the cabinet base. Run the cable without splice from inside the signal head to the base of the pole and provide 5 feet of slack for connection.

837.03.2 Furnish & Install Signal Head Section, Span Mount.

Furnish, assemble and install span mounted LED signal heads, housings and visors in the configuration shown in the Contract Documents. Complete wiring and electrical connections to make the signal head fully functional. Provide a minimum of a six section, twelve position terminal block capable of accepting three number 14 AWG spade terminal ends for each single and/or double section and the middle section of a three section signal head assembly. Place signal cable (paid under separate Contract Pay Items) along the span, down the pole and connect into the base. Run the cable without splice from inside the signal head to the base of the pole and provide 5 feet of slack for connection.

837.03.3 Furnish & Install LED Traffic Signal Head Indication Module.

Remove existing, and furnish and install new LED traffic signal head indication modules in existing signal heads. Complete wiring and electrical connections to make the signal head fully functional. Only use replacement modules compatible with the existing housing of the module being replaced.

837.03.4 Furnish & install Signal Head Backplate.

Furnish and install backplates in locations identified in the Contract Documents. Fabricate backplates as shown on the applicable detail sheet to match the required signal configuration.

837.03.5 Furnish & Install 16 inch LED Countdown Pedestrian Signal.

Furnish, assemble and install LED countdown pedestrian signal heads, visors and housings in the configuration shown in the Contract Documents. Complete wiring and electrical connections to make the pedestrian signal assembly fully functional. Furnish and install all components and hardware listed in Sections 837.02 of this Specification and on the mounting details shown in the Contract Documents. Place cable (paid separately under its respective Item) down the pedestal or pole and connect in the base. Run the cable without splice from inside the pedestrian signal head to the base of the pole and provide 5 additional feet for connection.

837.03.6 Furnish & Install LED Pedestrian Signal Head Indication 16 inch Module.

Remove existing and furnish and install new LED Pedestrian Signal Head modules in existing Pedestrian signal heads. Complete wiring and electrical connections to make the pedestrian signal head fully functional. Only use replacement modules compatible with the existing housing of the module being replaced.

837.03.7 Furnish & Install Pedestrian Pushbutton on Steel Pole with Sign.

Drill a 1/2 inch hole in the steel pole at the height and location shown in the Contract Documents. Drill and tap the steel pole for the two mounting bolts, using the pushbutton housing as a template, with the cable entrance hole aligned with the 1/2 inch hole in the pole. Install pushbutton housing using 1/4 inch x 1 inch bolts. Wire the pedestrian pushbutton and install on to the pushbutton housing; type and size of the cable as indicated by the Contract Documents. Run the cable without splice from inside the pedestrian pushbutton to the base of the pole and provide 5 additional feet for connection. Install the sign, supplied by the Department, in accordance with the Contract Documents.

837.03.8 Realign or Slide Existing Signal Head.

For span wire installations, loosen all saddle bolts and slide existing signal head to a specified location on the span wire. Re-tighten all bolts. To realign span mounted signal heads, loosen the two set screws on the top side of the head and the large nut inside the door of the top section. Re-tighten nut and set screws after realignment is complete.

For mast arm installations, loosen the mounting band brackets and adjust per manufacturer's instructions. Slide the signal head into new position and re-tighten the mounting band brackets. To realign mast arm mounted signal heads, loosen hardware per manufacturer's instructions, realign head and re-tighten hardware.

837.04 Method of Measurement.

A. The quantity of signal head sections will be measured as the actual number of signal head sections furnished, assembled and installed as required by the Contract Documents, complete in place and accepted. For example, a one-way 3 section signal assembly would constitute 3 EA pay units.

B. The quantity of LED traffic signal head indication modules will be measured as the actual number of modules furnished and installed in an existing signal head, complete in place and accepted. Removal and disposal of the modules being replaced is incidental to the Item and will not be measured separately.

C. The quantity of signal head backplates will be measured as the actual number of complete signal head backplate assemblies furnished, assembled, installed, complete in place, and accepted.

D. The quantity of LED countdown pedestrian signals will be measured as the actual number of LED countdown pedestrian signals furnished, assembled, installed, complete in place, and accepted.

E. The quantity of LED pedestrian signal head indications will be measured as the actual number of pedestrian signal head indications furnished and installed in an existing pedestrian signal housing, complete in place and accepted. Removal and disposal of the modules being replaced is incidental to the Item and will not be measured separately.

F. The quantity of pedestrian pushbuttons with signs will be measured as the actual number of pedestrian pushbuttons furnished, assembled, installed, complete in place, and accepted.

G. The quantity of existing signal heads realigned or slid will be measured, as the actual number of existing signal heads that are realigned or slid, complete in place and accepted.

837.05 Basis of Payment.

A. The quantity of signal head sections furnished and installed as specified, complete in place and accepted will be paid at the Contract Unit Price per each for the applicable Pay Items.

1. Price and payment constitute full compensation for furnishing and installing the signal head section, housing, wiring, electrical connection, visors, furnishing and installing the LED traffic signal head module, rigid mounting or span mounting and all related hardware to provide a fully functioning signal assembly and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

B. The quantity of LED traffic signal head indication modules furnished and installed in existing signal heads, complete in place and accepted will be paid at the Contract Unit Price per each for the applicable Pay Items.

1. Price and payment constitute full compensation for furnishing and installing the LED traffic signal head indication in an existing signal head, removal and disposal of the existing LED module being replaced and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

C. The quantity of signal head backplates furnished, assembled and installed, complete in place and accepted will be paid at the Contract Unit Price per each for the applicable Pay Items.

1. Price and payment constitute full compensation for furnishing, assembling and installing the signal head backplate, retroreflective border and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

D. The quantity of LED countdown pedestrian signals furnished, assembled and installed, complete in place and accepted will be paid at the Contract Unit Price per each for the applicable Pay Items.

1. Price and payment constitute full compensation for furnishing and installing the assembly, housing, wiring, electrical connection, visors, mounting and all related hardware to provide a fully functioning pedestrian signal and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

E. The quantity of LED pedestrian signal head indication modules installed in existing pedestrian signal housings, complete in place and accepted will be paid at the Contract Unit Price per each for the applicable Pay Items.

1. Price and payment constitute full compensation for furnishing and installing the LED pedestrian signal head module in an existing pedestrian signal housing, removal and disposal of the existing LED module being replaced and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

F. The quantity of pedestrian pushbutton assemblies installed, complete in place and accepted will be paid at the Contract Unit Price per each for the applicable Pay Items.

1. Price and payment constitute full compensation for furnishing, assembling and installing the pushbutton assembly, wiring, electrical connection, sign installation, mounting and all related hardware to provide a fully functioning pedestrian pushbutton and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer. Supply as necessary any control Equipment necessary for the pushbutton assemblies to operate as specified herein at no additional charge. Incorporate costs for such control Equipment into the Unit Price for the pushbutton assembly.

2. Furnishing of required sign is not included in this Item as the sign will be furnished by the Department.

G. The quantity of existing signal heads realigned or slid, complete in place and accepted will be paid at the Contract Unit Price per each for the applicable Pay Items.

1. Price and payment constitute full compensation for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
837001	FURNISH & INSTALL 8” LED SIGNAL HEAD SECTION, RIGID MOUNT	EA
837002	FURNISH & INSTALL 12” LED SIGNAL HEAD SECTION, RIGID MOUNT	EA
837003	FURNISH & INSTALL 8” LED SIGNAL HEAD SECTION, SPAN MOUNT	EA
837004	FURNISH & INSTALL 12” LED SIGNAL HEAD SECTION, SPAN MOUNT	EA
837005	FURNISH & INSTALL 8” LED TRAFFIC SIGNAL HEAD INDICATION MODULE	EA
837006	FURNISH & INSTALL 12” LED TRAFFIC SIGNAL HEAD INDICATION MODULE	EA
837007	FURNISH & INSTALL SIGNAL HEAD BACKPLATE	EA
837008	FURNISH & INSTALL 16” LED COUNTDOWN PEDESTRIAN SIGNAL	EA
837009	FURNISH & INSTALL 16” LED PEDESTRIAN SIGNAL HEAD INDICATION MODULE	EA
837010	FURNISH & INSTALL PEDESTRIAN PUSHBUTTON WITH SIGN	EA
837011	REALIGN OR SLIDE EXISTING SIGNAL HEAD	EA

SECTION 838 – SPAN WIRE AND MESSENGER WIRE

838.01 Description.

Furnish, install, transfer, adjust, relocate or remove span wire and messenger wire and associated attachments in accordance with the Contract Documents and as directed by the Engineer.

838.02 Materials.

Provide Materials as specified in:

Span Wire and Messenger Wire	Section 1076

838.03 Construction.

838.03.1 Span Wire.

Furnish and install span wire on steel or wood poles at the locations described on the Plans and as directed by the Engineer. The tension of the installed span wire and the attachment height will be specified by the Engineer. Apply tension to the span wire using a tensioning device with a minimum capacity of 6,000 pounds pull.

A. Steel Pole Preparation: No preparation is required for attaching a span wire between steel poles.
B. Wood Pole Preparation: Prepare wood poles as follows:

1. Install two strain plates on each pole, one on the front and one on the back, as shown in the Standard Construction Details.

2. On each pole, install two guy hooks, one on each side of the pole, as shown in the Standard Construction Details.

C. Span Wire Installation: Install span wire in accordance with all applicable electrical and safety codes. Install strain insulators based on field conditions and as directed by the Engineer. Equip each span with two strain insulators unless otherwise directed by the Engineer. Install the strain insulator no less than 8 feet above the ground if the span wire is broken below the insulator.

Attach span wire to the poles and strain insulators in the following manner:

1. Starting at the pole nearest the strain insulator, wrap the span wire one and one half times around the pole with the end of the span wire extending back parallel with the span. Do not allow the span wire to cross over or overlap itself on the pole.

2. Place two galvanized guy clamps on the span wire end-to-end so that the guy clamp nearest the pole is 2.5 feet from the pole. Install the other guy clamp to have a 1 inch separation from the guy clamp nearest the pole.

3. Extend the end of the span wire at least 3 feet from the last clamp and properly secure the span wire with a service sleeve.

4. Place a strain insulator by doubling back the span wire through the appropriate hole in the insulator. Attach the doubled back span wire to the other span wire using two galvanized guy clamps placed end-to-end at a distance of 1 foot from the strain insulator. Extend the end of the span wire at least 3 feet from the last clamp and properly secure the span wire with a service sleeve.

5. Attach a span wire to the other side of the strain insulator in the same manner as in Step 4.

6. Wrap the span wire around the far pole to complete the system. Tension the span wire in an appropriate manner to achieve the tension as specified in the Contract Documents. Use the tensioning device on the end of the span farthest from the strain insulator. Wrap and clamp the wire in the same manner as described above in Steps 1 and 2. Extend the end of the span wire at least 3 feet from the last clamp and properly secure the span wire with a service sleeve.

838.03.2 Dead End Messenger Wire Attachment. The tension of the messenger wire in the dead end attachment will be specified by the Engineer.

A. Installation on a Wood Pole: Drill a proper size hole through the wood pole at the height specified by the Engineer. Install an eyebolt of appropriate length such that it is passed through the washer, through the pole and through the back washer. If the Engineer determines that a down guy assembly is required, install a guy attachment on the back of the pole in lieu of the back washer. Tighten the nut on the eyebolt assembly enough to compress the down guy attachment. Install the second nut to act as a lock nut. Attach the service wedge clamp and messenger wire to the eyebolt.

B. Installation on a Steel Pole: Wrap the messenger wire around the steel pole one and one half times with the end of the messenger wire extending back parallel with the messenger wire run. Do not allow the span wire to cross over or overlap itself on the pole. Place two galvanized clamps on the messenger wire end in accordance with the Standard Construction Details. Extend the end of the messenger wire at least 3 feet from the last clamp and properly secure the messenger wire with a service sleeve.

838.03.3 Intermediate Messenger Wire Attachment. Sections 838.03.3.A and 838.03.3.B apply to wood poles only. Do not use these Sections for steel poles.

A. Straight Run at Intermediate Poles: Install a straight run intermediate messenger wire attachment as follows:

1. Tension the messenger wire as directed by the Engineer then fit the proper clamp over the messenger wire and tighten the outside two clamp bolts.
2. Drill a proper size hole through the pole at the height specified by the Engineer.
3. Install a machine bolt of appropriate length such that it be passed through the center bolt hole of the clamp, through the guy hook, through the pole, through the washer and properly tightened with a nut. Install a second nut to act as a lock nut.
4. Install a parallel groove connector on the messenger wire within 6 inches of the clamp. Install the #4 split-bolt connector onto the wood pole ground wire. Install a proper length of #6 AWG solid copper wire between the parallel groove connector and the split-bolt connector and tighten all hardware.

B. Angular Run at Intermediate Poles: Install an angular run intermediate messenger wire attachment as follows:

1. Drill a proper size hole through the pole at the height specified by the Engineer.
2. Install an eyebolt of appropriate length such that it is passed through the washer, through the pole and through the back washer. If a down guy assembly is shown in the Plans or directed to be installed by the Engineer, install a guy attachment on the back of the pole in lieu of the back washer. Tighten the nut on the eyebolt assembly enough to compress the down guy attachment. Install the second nut to act as a lock nut.
3. Assemble the two service wedge clamps and the messenger wire to the eyebolt assembly as shown in the Contract Documents.
4. Install a parallel groove connector on the messenger wire within 6 inches of the eyebolt. Install the #4 split-bolt connector onto the wood pole ground wire. Install a proper length of #6 AWG solid copper wire between the parallel groove connector and the split-bolt connector and tighten all hardware.

838.03.4 Adjustment of Span or Messenger Wire.

Make adjustments of existing span or messenger wire including tightening, raising and tightening, loosening or other Work only as directed by the Engineer.

A. Tighten or Raise and Tighten Existing Span or Messenger Wire. Span or messenger wire may be tapped to desired height once tension is removed. To tighten the span or messenger wire, attach another tensioning device between the loose end of the span or messenger wire and tighten. When the desired tension is reached, re-tighten the 3-bolt guy clamps and remove tensioning devices. Adjust the span bonding jumper as required. Adjustment may need to be made on both ends of one span to tighten or raise and tighten the

span or messenger wire at the direction of the Engineer and this will be paid as one (1) "Adjustment of Span or Messenger Wire."

B. Loosen Existing Span or Messenger Wire. Attach a tensioning device between the pole and span or messenger wire beyond the strain insulator. Loosen or remove the two 3-bolt guy clamps. Adjust the span bonding jumper as required.

838.03.5 Relocation of Messenger Attachment.

Support the cable in a manner as not to damage the cable. Drill a hole in the existing pole at the location specified by the Engineer. The cable and attachment raised or lowered and installed using the same hardware on the same pole location does not require removal of the wire from the messenger. Adjust the messenger bonding jumper as required.

838.03.6 Transfer of Existing Span or Messenger Attachment.

Support the cable in a manner so as not to cause any damage. Drill a hole in the new pole at the location specified by the Engineer. Move the cable and attachment to the new pole and install using the same hardware from the original pole. Supply additional hardware as part of this Work at no additional cost if additional hardware is required to attach the span or messenger to the new pole. Reattach the messenger bonding jumper to the new pole ground wire.

838.03.7 Removal of Messenger Wire, Cable and Hardware.

Removal of messenger wire, cable and hardware consists of the removal of a messenger wire with a cable attached or of a cable with a built-in messenger wire in place between poles. This Item is not applicable to the removal of cable from a messenger wire, which remains in place or the removal of a messenger wire that has no cable attached or built-in.

Use a tensioning device to remove the tension from the clamps before their release. Do not cut the messenger wire while under tension. Lower the messenger wire to the ground by hand or hand line after removing the clamps and backing off all of the tension. Detach the cable that is attached to the messenger wire by lashing or tape (not built-in).

838.04 Method of Measurement.

838.04.1 Span Wire.

The quantity of span wire cable installed between poles, measured from the center of pole or Structure to the center of pole or Structure (wood or metal), set at the proper tension and height, installed, complete in place and accepted will be measured on a per linear foot basis. No separate measurement will be made for span wire wrapped around the pole or Structure.

838.04.2 Messenger Wire Attachment.

The quantity of dead end, intermediate or angular messenger wire attachments will be measured on a per each basis as the number of attachments of messenger wire made to a pole, complete in place and accepted. If a down guy assembly is required, it will be measured in accordance with Section 840.

838.04.3 Adjustment of Span or Messenger Wire.

The quantity of span or messenger wires adjusted will be measured as the number of span or messenger wires adjusted, complete in place and accepted.

838.04.4 Relocation of Messenger Attachment.

The quantity of relocations will be measured as the number of messenger wire attachments relocated, complete in place and accepted.

838.04.5 Transfer of Existing Span or Messenger Attachment.

The quantity of span or messenger attachment transfers will be measured as the number of span or messenger wire attachments transferred, complete in place and accepted.

838.04.6 Removal of Messenger Wire, Cable and Hardware.

The quantity of messenger wire removed will be measured as the number of linear feet of messenger wire with attached cable removed and disposed of, completed and accepted.

838.05 Basis of Payment.

838.05.1 Span Wire.

The quantity of span wire set at the proper tension and height, installed, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
838001	FURNISH & INSTALL SPAN WIRES, 7/16”	LF
838002	FURNISH & INSTALL SPAN WIRES, 1/4”	LF

Price and payment constitute full compensation for furnishing all Materials and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

No separate payment will be made for wood pole preparation.

No separate payment will be made for labor and Materials necessary to attach span wire between poles for “H”, “Suspended Box” or other types of span installations.

No separate payment will be made for span wire wrapped around the pole or Structure. This Work and Material is incidental to the appropriate Bid Item.

838.05.2 Messenger Wire Attachment.

The quantity of dead end, intermediate or angular intermediate messenger wire attachments made to a pole, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
838003	FURNISH & INSTALL DEAD END MESSENGER WIRE ATTACHMENT	EA
838004	FURNISH & INSTALL INTERMEDIATE MESSENGER WIRE ATTACHMENT	EA
838005	FURNISH & INSTALL ANGULAR INTERMEDIATE MESSENGER WIRE ATTACHMENT	EA

Price and payment constitute full compensation for furnishing the messenger wire attachment hardware, attaching the messenger wire to a wood or steel pole and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer. If a down guy assembly is required, it will be paid in accordance with Section 840.

838.05.3 Adjustment of Span or Messenger Wire.

The quantity of span or messenger wires adjusted, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
838006	ADJUSTMENT OF SPAN OR MESSENGER WIRE	EA

Price and payment constitute full compensation for tightening, raising and tightening or loosening the span or messenger wire and for all labor, tools, Equipment and incidentals necessary to complete the Work. No payment will be made for removal or installation of tape on span to clear a path for tensioning devices. No payment will be made for tightening span or messenger wires on new installations.

838.05.4 Relocation of Messenger Attachment.

The quantity of messenger attachment relocations, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
838007	RELOCATION OF MESSENGER ATTACHMENT	EA

Price and payment constitute full compensation for all labor, tools, Equipment and incidentals necessary to complete the Work.

838.05.5 Transfer of Existing Span or Messenger Attachment.

The quantity of span or messenger attachments transferred, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
838008	TRANSFER OF EXISTING SPAN OR MESSENGER ATTACHMENTS.	EA

Price and payment constitute full compensation for all labor, tools, Equipment and incidentals necessary to complete the Work.

838.05.6 Removal of Messenger Wire, Cable and Hardware.

The quantity of messenger wire removed and disposed of, completed and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
838009	REMOVAL OF MESSENGER WIRE, CABLE AND HARDWARE	LF

Price and payment constitute full compensation for all labor, tools, Equipment and incidentals necessary to complete the Work.

SECTION 839 – WOOD POLES

839.01 Description.

Furnish, install, cut or remove wood poles in accordance with the Contract Documents and as directed by the Engineer.

839.02 Materials.

Provide Materials as specified in:

Wood Pole	Class II – 40’ in length
#6 AWG Solid Bare Copper Ground Wire	Section 832; Section 1074
Ground rod	Section 833
Butt plate	As required
Copper Coated Fasteners	As required
Ground Clamp	Section 833
Borrow Type F	Section 209
Topsoil	Section 908
Seed	Section 908
Mulch	Section 908

838.03 Construction.

839.03.1 Installation.

Furnish and install wood pole (ANSI O5.1) with a butt plate and #6 bare copper ground wire from the butt plate to the top of the pole. A ground rod may be used in place of the butt plate. Locate the pole as shown in the Contract Documents and as directed by the Engineer. Excavate a hole 10 feet in depth or as directed by the Engineer. Dig the hole in such a manner as to preclude over-sizing the diameter. Erect and set the pole vertically in all directions, unless otherwise specified. After the pole is erected, place approved Material in the hole around the wood pole to fill the void completely and provide a ridge around the hole after it has been properly filled. Place backfill Material to achieve 95 percent compaction in accordance with Section 202.

Use copper coated fasteners, placed not more than 3 feet apart, to install the ground wire to the wood pole. If a ground rod is utilized, drive the ground rod vertically into the ground in accordance with Section 833. Butt plates and/or ground rods will be incidental to the installation of the wood pole.

839.03.2 Cutting of Wood Pole.

Follow applicable safety codes and regulations. Remove all metal (cables, staples, ground wires, etc.) from the pole in the area of the cut. Secure the pole above the area of the cut with a properly sized lifting device. Use an adequate saw to cut the pole to the height specified. After the pole is cut, lower the cutoff piece of pole to the ground in a safe and controlled manner. Remove the cutoff pole piece and all removed metal from the job site and dispose of in accordance with Section 106.08.

839.03.3 Removal of Wood Pole.

Remove all hardware and connections from the pole, including the ground rod. Extract the wood pole from the ground using a crane or other sufficient lifting device. Place Borrow Type F in the remaining hole to fill it and to match the existing elevation of the surrounding area. Place backfill Material to achieve 95 percent compaction in accordance with Section 202. Place topsoil; seed and mulch in accordance with Section 908. If a butt plate is used, leave it intact.

839.04 Method of Measurement.

The quantity of wood poles furnished and installed will be measured as actual number of wood poles furnished, installed, complete-in-place and accepted.

The quantity of wood poles cut will be measured as the actual number of wood poles cut to the specified height complete-in-place and accepted.

The quantity of wood poles removed will be measured as the actual number of wood poles removed as specified.

839.05 Basis of Payment.

The quantity of wood poles furnished, installed, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
839001	FURNISH & INSTALL WOOD POLE	EA

Price and payment constitutes full compensation for furnishing and transporting the wood pole, excavating the hole, furnishing and installing the butt plate or ground rod, furnishing and installing fasteners for the ground wire, backfill and backfilling, and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer. Ground wire will be paid under Section 832.

The quantity of wood poles cut to the height specified, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
839002	CUTTING OF WOOD POLE	EA

Price and payment constitutes full compensation for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

The quantity of wood poles removed will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
839003	REMOVAL OF WOOD POLE	EA

Price and payment constitutes full compensation for removing and disposing of the pole and parts, for backfill and backfilling, grading, topsoil, seeding and mulching; and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

SECTION 840 – DOWN GUYS AND ANCHORS

840.01 Description.

Furnish, install, relocate and/or remove down guy and anchor, sidewalk guy and anchor or overhead guy in accordance with the Contract Documents and as directed by the Engineer.

840.02 Materials.

Provide Materials as specified in:

Guys and Anchors	Section 1077

840.03 Construction.

840.03.1 Down Guy and Anchor.

840.03.1.1 Furnish and Installation.

Furnish all Materials to install the down guy and anchor. Drive the anchor at 45 degrees away from the pole into firm and undisturbed ground to a point at which no more than 6 inches of the rod, including the eye, is exposed above ground level. Attach the down guy or sidewalk guy wire to the anchor end of the pole at the appropriate location on the pole to provide guying for the cable installed for Department's use. Install the guy in accordance with all applicable electrical and safety codes. Install the strain insulator based on field conditions and as designated by the Engineer. Install the strain insulator at a location such that the strain insulator is not less than 8 feet above the ground if the guy is broken below the insulator. Install a guy wire protector with the bottom at ground level and properly anchored to the guy wire. Bond the guy to the wood pole ground.

840.03.1.2 Relocation.

This Work consists of moving the location of a down guy or a sidewalk guy and the associated anchor. Ensure the guy remains attached to the same pole, but change the location of the anchor. Salvage as much of the existing guy as possible. Submit the method of relocation of the down guy or the sidewalk guy to the Engineer for approval.

840.03.1.3 Removal.

Submit the method of removal of the anchor and the down guy or the sidewalk guy for the approval of the Engineer.

840.03.2 Overhead Guy.

840.03.2.1 Furnish and Installation.

Attach the guy wire to the pole at the appropriate location on the pole to provide overhead guying for aerial cable. Install the guy according to all applicable electrical and safety codes. Install a strain insulator based on field conditions and as directed by the Engineer. Install the strain insulator at a location such that the strain insulator is not less than 8 feet above the ground if the guy is broken below the insulator. Bond each end of the guy to the wood pole ground.

840.03.2.2 Relocation.

The method of relocation of the overhead guy is left to the discretion of the Contractor.

840.03.2.3 Removal.

Submit the method of removal of the overhead guy to the Engineer for approval.

840.04 Method of Measurement.

Measure the quantity of anchors and down guys, sidewalk guys or overhead guys as the actual number of anchors and down guys or sidewalk guys furnished and installed, relocated or removed as specified, complete in place and accepted.

840.05 Basis of Payment.

840.05.1 Furnish and Installation of Guy and Anchor.

The anchors and down guys, sidewalk guys or overhead guys furnished, installed, complete in place and accepted will be paid for at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
840001	FURNISH & INSTALL DOWN GUY AND ANCHOR	EA
840002	FURNISH & INSTALL OVERHEAD GUY	EA

Price and payment constitutes full compensation for all Materials, labor, tools, Equipment and incidentals necessary to complete the Item. Bonding of the guys is incidental to the Item as specified and as directed by the Engineer.

840.05.2 Relocation of Guy and Anchor.

The anchors and down guys, sidewalk guys or overhead guys relocated, complete in place and accepted will be paid for at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
840003	RELOCATION OF DOWN GUY AND ANCHOR	EA
840004	RELOCATION OF OVERHEAD GUY	EA

Price and payment constitutes full compensation for all Materials, labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

840.05.3 Removal of Down Guy and Anchor.

The anchors and down guys or sidewalk guys removed will be paid for at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
840005	REMOVAL OF DOWN GUY AND ANCHOR	EA
840006	REMOVAL OF OVERHEAD GUY	EA

Price and payment constitutes full compensation for all Materials, labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

SECTION 841 – WEATHERHEADS

841.01 Description. Furnish and install a weatherhead of compatible Materials to what it is installed on as indicated in the Contract Documents and as directed by the Engineer.

841.02 Materials. Provide Materials as specified in:

Close Nipple	Section 1062
Lock Nut	Section 1062

Conduit Bushing – plastic conduit bushing or insulated bushing

841.03 Construction. Locate the weatherhead in a hole drilled six inches from the top of the steel pole on the side parallel with the span cable and as directed by the Engineer. Ensure the hole for the nipple is snug. Drill the hole using a hole saw. The Engineer will not accept any other means of drilling hole in the pole. Install the weatherhead on a close nipple. Place a lock nut on the nipple and then place the assembly through the hole drilled into the steel pole. After the weatherhead assembly is in place, use a bushing, seated firmly on the end of the nipple inside the steel pole, to secure the assembly. Tighten the lock nut against the outside of the steel pole to hold the complete assembly in place.

841.04 Method of Measurement. Measure the quantity of weatherheads as the actual number of weatherheads furnished and installed, complete in place and accepted.

841.05 Basis of Payment. Weatherheads furnished, installed, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
841001	FURNISH & INSTALL WEATHERHEAD, UP TO 3”, ON STEEL POLE	EA

Price and payment constitutes full compensation for furnishing and installing the weatherheads, including hardware, labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

SECTION 842 – SERVICE PEDESTAL AND SAFETY SWITCH

842.01 Description.

Furnish, install, and remove lighting and traffic service pedestals and safety switches in accordance with the Contract Documents and as directed by the Engineer.

842.02 Materials.

Provide Materials as specified in:

Service Pedestal and Safety Switch	Section 1078
Ground Rod & Wire	Section 833
Cables and Wires	Section 832
Conduit & Fittings, Galvanized Steel	Section 831; Section 1062
Hex Bolts & Washers, Stainless Steel	Section 1039
Square Tube Steel Posts	Section 1039
Portland Cement Concrete, Class B	Section 1022
Galvanizing	Section 1039
Pedestal Board	Section 1078

842.03 Construction.

A. General

1. Perform all Work in compliance with NEC, NFPA, and NESC Standards and with utility company minimum requirements.
2. Install Electric Service Pedestal as shown in the Standard Construction Details.
3. Locate line side safety switch and meter adjacent to service drop location.
    a. Fuse and size line side safety switch to service.
4. Do not fuse the load side safety switch.
5. Mark safety switch with weatherproof stamp.
    a. Label switch “Lighting”, “Signal”, “Camera”, “Repeater”, “VMS”, “Detector” or “RWIS”, denoting the device it serves.
6. Tighten all conduits and hardware connections with the appropriate wrenches or tools.

B. Lighting Service Pedestal

1. Excavate area for service pedestal.
    a. Where a pole base is to be placed in existing concrete pavement such as a sidewalk, saw cut the concrete in a square pattern or remove the concrete to the nearest joint.
2. Install conduit.
    a. Use a conduit adapter to connect sweeps to underground conduit and conduit leading to the safety switch and meter.
    b. Install an appropriate length of 2 inch galvanized conduit (threaded and reamed on both ends) on the end of the 90 degree sweeps at the base of the pedestal board so that the end of the conduit will be 3 feet above the finished grade of the area.

i. Install square tube steel posts per Standard Construction Details in 12 inch X 12 inch X 36 inch concrete footings.

c. Provide 3 inch clearance on the base of footing.

3. Backfill around the conduit and concrete footings and dispose of excess or unsuitable materials to grade of the bottom of concrete footings.

   a. Backfill may be placed after the first 24 hours. Backfill in accordance with Section 202.

   b. Remove all excess material. Suitable Material may be used elsewhere on the Project as directed by the Engineer.

4. Set square tube steel posts.

   a. Determine the finished length of the tubular steel posts by adding the total height of the meter and safety switch to 5 feet.

5. Install ground rod in accordance with the Contract Documents and Section 833.

6. Attach pedestal board to square tube steel posts using stainless steel hex bolts and washers.

7. Arrange inspection by a Delaware licensed electrical inspection agency for all lighting system Work including but not limited to service, branch circuits, junction wells, underground conduit, all grounding and bonding and any electrical Work performed on the Project.

   a. Submit certification for the Delaware licensed electrical inspection agency to the Engineer for approval prior to starting Work.

8. If required by the Contract Documents, remove electric service from wood or metal pole as directed by the Engineer.

842.04 Method of Measurement.

The quantity of electric services will be measured as the actual number of complete electric services installed, complete in place and accepted.

842.05 Basis of Payment.

The quantity of electric services installed will be paid at the Contract Unit Price each electric service of the size and type specified, installed, complete in place, and accepted. Price and payment constitutes full compensation for all Materials, including ground rods and for all labor, tools, inspection by Delaware licensed electrical agency, and incidentals necessary to complete the Item as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
842001	ELECTRIC SERVICE ON WOOD POLE	EA
842002	ELECTRIC SERVICE ON METAL POLE	EA
842003	ELECTRIC SERVICE ON PEDESTAL	EA
842004	ELECTRIC SERVICE ON PEDESTAL WITH SERVICE RISER	EA
842005	REMOVAL OF ELECTRIC SERVICE ON WOOD OR METAL POLE	EA
842006	FURNISH AND INSTALL EMBEDDED METERED SERVICE PEDESTAL (100 AMP)	EA
842007	FURNISH AND INSTALL ELECTRICAL UTILITY SERVICE EQUIPMENT 120/240	EA

SECTION 843 – ELECTRICAL TESTING

843.01 Description.

Furnish all Materials, Equipment, tools, and labor necessary to perform electrical testing in accordance with the Contract Documents and as directed by the Engineer.

When this Item is required to test a highway lighting system constructed as part of the Contract, include a one year warranty of the highway lighting system installed under the Contract. The highway lighting system includes all Items of Work performed under the Contract to provide lighting of roadways, bike paths, parking lots, etc.

The highway lighting system is comprised of all Contract Items for lighting, including but not limited to conduits, junction wells, cables, load centers, transformers, cabinet pads, pole bases, poles, high mast poles, light standards with and without davit arms, luminaires, service installations and reworked/relocated existing lighting facilities.

843.02 Materials. Not Applicable.

843.03 Construction Methods.

Perform all Work in conformance to the latest editions of the National Electrical Code (NEC), the National Electrical Safety Code (NESC), local utility company requirements, and state and local laws and ordinances governing the Work. Complete all Work under the direct supervision of a master electrician licensed in the State of Delaware. Submit a copy of the master electrician's license to the Engineer for approval. Apply for, obtain and pay for all permits, licenses and inspections required by local regulation. All electrical installations must pass an electrical inspection by a Delaware-approved Licensed Electrical Inspection Agency.

At least 30 Days prior to the commencement of each test, submit the types, styles, or catalog numbers of all required testing Equipment. Include a written certification stating when the testing Equipment was last calibrated. Ensure the calibration date is within 180 days of the date when the tests are to be performed. Perform all tests in the presence of the Engineer.

843.03.1 Ground Resistance Testing.

Measure ground resistance with a three-terminal, fall-of-potential, direct-reading, battery-powered earth tester with a 0.50 to 500 ohm scale or digital read-out. Ensure the 25 ohm reading is approximately at mid-scale. Perform the test according to the manufacturer's instructions and OSHA requirements. Perform the test when the soil is dry. Do not add any chemical or salt solutions to any portion of the grounding system. Install all grounding rods and foundation grounds to be tested a minimum of ten days prior to testing unless otherwise determined by the Engineer in the field. Drive two auxiliary copper clad ground rods into the ground at a minimum distance of 3 feet. Provide the lateral spacing for each test rod in writing on the test report form and the spacing will be approved by the Engineer. Isolate each ground rod or foundation ground with the bond wires disconnected when the test is being performed. Ensure the resistance to ground is 25 ohms or less. Perform two ground resistance tests unless noted otherwise in the Contract Documents.

843.03.2 System Testing.

Perform all system testing for lighting installations by a third-party licensed master electrician in the State of Delaware.

Test insulation from ground, roadway lighting, performance (burn-in) and illuminance circuits as follows:

A. Insulation from Ground. Test all underground circuits for resistance to ground with a megger both before and after the conduit and wiring have been buried and all ground rods have been installed and connected. Circuit measurement readings less than 10 megaohms to ground are not acceptable. Inspect, repair and retest failing circuits.

B. Roadway Lighting Circuits. Determine the insulation resistance on all cables of every circuit, except those installed in lighting structures. Cable insulation resistance measurement readings less than 10 megaohms at 500 volts D.C. are not acceptable. If the insulation resistance test of any conductor is less than 10 megaohms, locate the fault. If the fault is in a conductor between terminal connections, replace the

conductor. If the fault is at a terminal connection, repair or replace the terminal device. Removing water from the conduit of a fault circuit is not considered a repair. If a circuit fails the insulation resistance test and removing water allows the circuit to pass, replace the conductors and re-test the new circuit. Endure the duration of circuit testing and any re-test is at least one minute.

Demonstrate to the Engineer that all conductors are continuous, free from short circuits and unspecified grounds, and that all circuits are properly connected.

Take voltage readings, with load and without load, at the power supply side of the control cabinet main breaker. The readings with load must be within +/- 5 percent of nominal voltage. Take voltage readings at the last light of each circuit. A voltage reading is acceptable if it is within 5 percent of the reading with load at the supply point.

Take current (ampere) readings with a full lighting load on the load side of each distribution breaker in the control cabinet. A current reading is acceptable if it does not exceed 80 percent of the breaker rating.

C. Performance (burn-in). After all issues mentioned in previous tests have been addressed to the satisfaction of the Engineer, perform a 2 week burn-in test on the lighting system. The burn-in test consists of normal dusk-to-dawn operation of all lighting system control Equipment and apparatus to ensure function without interruption or failure. Conduct the burn-in test at the same time for all lights that are energized from the same utility company service point. Burn-in test of individual circuits or groups of lights will not be acceptable.

   At the end of the burn-in test, inspect all lights and Equipment for normal operation. Correct failures occurring during the test period. Make any necessary repairs or replacements at no cost to the Department. Perform a retest on the repair portion of the system.

D. Illuminance. After the lights have been energized for the minimum 2 week burn-in period, arrange a night-time inspection with the Department's Master Electrician to determine the optical qualities of each luminaire. Adjust all luminaires having unsatisfactory qualities as directed. Conduct an illumination test to determine illumination characteristics of the roadway lighting system. Submit test procedures to the Engineer for approval two weeks prior to conducting the test. Submit four copies of the test results to the Engineer.

843.03.3 Inspection.

All Work will be inspected and approved by the Engineer before concealment. Hire a third-party inspection agency for certification and sticker placement for the entire electrical system. This inspection agency must be independent and licensed to operate in the State of Delaware, having no affiliation with the Department or the Contractor. Inspection is to be made during the progress and after the Work has been completed. The certification inspection includes the lighting control cabinets, cables and all other components of the lighting system. Submit four (4) copies of the inspection agency's certification document to the Engineer. The Project will not be accepted as complete and energizing of the lighting system is not permitted until after receipt of a certification document. The Department will not conduct its final electrical inspection until after receipt of the inspection agency's certification document. The inspection agency is also required to submit a "cut-in card" to the utility company prior to energizing the service.

The Department will inspect the highway lighting system within the Project limits for both day and night acceptability considering all the possible defects listed in Section 843.03. If the highway lighting system is considered defective because of abnormal operation or deterioration (as listed in Section 843.03), the Department will require repair or replacement of the defective Equipment.

843.03.4 As-Built Plans.

Submit two (2) complete sets of as-built plans, including one set of CADD files, for review upon completion of the Work, showing the location of all buried electrical circuits, with lighting system elements dimensioned from fixed objects or from survey stations. Provide vertical dimensions related to finished ground level for all underground electrical facilities. Include in the as-built plans all of the plan and detail sheets of the Project with all changes indicated. Also in the submission, include paper and electronic copies of catalog cuts of all Equipment used for the

lighting system. Keep a daily record of the location of all Items in order to ensure the accuracy of the as-built plans.

843.03.5 Highway Lighting System Warranty.

Secure the manufacturer's warranties and/or guarantees on electrical and/or mechanical Equipment. Submit these warranties and/or guarantees upon Final Acceptance of the completed highway lighting system. In addition to the manufacturer's warranties and/or guarantees, provide a warranty for the complete, installed highway lighting system to be free of defects, as hereafter defined, for one calendar year beginning at the initial acceptance of the highway lighting system. The Engineer will consider the highway lighting system defective if any of the following conditions (not considered all inclusive) are discovered by visual inspection or by inspection with testing Equipment within the warranty period:

A. Non-operational lamps or ballasts.

B. Failure to operate, in whole or in part.

C. Power wire grounding less than ten megaohms.

D. Shifts in pole/foundation alignment.

E. Short circuits or open circuits anywhere within the system.

F. Deterioration of finishes, plating, or paint not normal and customary in the environment in which the Equipment is installed.

G. Settlement of trench backfill.

H. Defective fuses.

I. Defective or improperly installed splices.

Repair, in accordance with this Section, all defective areas, including all highway lighting systems and components within the Project limits, identified by the Department during initial or periodic inspections. Begin all highway lighting system repairs immediately following the notice to the Contractor of the lighting system defect unless weather limitations prevent the corrective Work. Provide notification to the Department before beginning corrective Work and allow the Department to fully inspect all operations.

The highway lighting system will not be considered substantially complete until all deficiencies noted during the final inspection have been corrected. Upon Substantial Completion of the Work, the Contractor shall furnish to the Department a Maintenance Bond for Item 843001 – Electrical Testing. Provide the Maintenance Bond meeting the following requirements:

A. A sum equal to 100 percent of the value of all highway lighting system Items paid to the Contractor;

B. All signatures are original signatures, in ink, and not mechanical reproductions or facsimiles of any kind;

C. The Contractor is named the principle;

D. The term of the bond is for one year;

E. The term of the Maintenance Bond will be for a period of one year beyond the completion of the highway lighting system Work; and

F. Written by a Surety or insurance company that is in good standing and currently licensed to write surety bonds in the State of Delaware by the Delaware Department of Insurance.

If at any time during the warranty period the highway lighting system or any portion is rendered defective as a result of anything other than a manufacturing or construction defect, the Department will repair, replace or revise the system at its sole option. The Contractor will not be held responsible for the cost to correct failures due to design defects in the highway lighting system.

843.04 Method of Measurement.

The quantity of electrical testing will not be measured.

843.05 Basis of Payment.

The quantity of electrical testing will be paid at the Contract lump sum price. Price and payment constitute full compensation for furnishing all testing Equipment, including ground rods; performing the tests; inspections by a licensed third-party inspection agency; preparing the reports, performing any necessary retesting; and for all labor, Equipment, tools, and incidentals required to complete the Work as specified and as directed by the Engineer. For highway lighting systems, price and payment also constitute full compensation for providing the warranties and performing any necessary corrective Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
843001	ELECTRICAL TESTING	LS

SECTION 844 – EMERGENCY PREEMPTION DETECTOR

844.01 Description.

Furnish, assemble, wire and install emergency preemption detector on a mast arm or span wire in accordance with Contract Documents and as directed by the Engineer.

844.02 Materials.

Provide Materials as specified in:

A. Detector cable – to be supplied and installed by the Contractor, paid under Section 832.

B. Emergency preemption detector – Opticom Model 721 and associated hardware, or approved equal

C. Teflon tape

D. Waterproof 3/4-inch wide vinyl plastic tape in the following colors

1. Manufacturers
    a. 3M Company Cat. No. 33
    b. Plymouth Rubber Cat. No. 3117
    c. Permacel Cat. No. P29
    d. Approved equal
2. Colors needed:
    a. Violet
    b. Red
    c. Green
    d. Yellow
    e. Blue

844.03 Construction.

Assemble mounting hardware as shown in the Contract Documents. Use thread sealing tape on the mounting hardware. Drill a 1/8 inch diameter weep hole on the bottom of the detector. Install the emergency preemption detector as required. Attach the four-conductor detector cable to the four terminal screws within the emergency preemption detector unit according to manufacturer specifications.

Identify the detector cable “home run” within the control cabinet by a violet band PLUS a band of a different color to denote the direction of the detector:

A. RED – northbound eye

B. GREEN – eastbound eye

C. YELLOW – southbound eye

D. BLUE – westbound eye

Emergency preemption detectors that are removed are to be disposed of per Contract requirements.

844.04 Method of Measurement.

Measure the quantity of emergency preemption detector installations as the actual number of emergency preemption detectors furnished, assembled and installed on span wire or traffic signal mast arms, complete in place and accepted.

844.05 Basis of Payment.

Emergency preemption detectors furnished, assembled, installed, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DECRIPTION	UNIT
844001	FURNISH & INSTALL OPTICOM EMERGENCY PREEMPTION DETECTOR	EA

Price and payment constitutes full compensation for furnishing, assembling and installing the emergency preemption detectors, removal and delivery to the Department of any existing units being replaced and hardware, labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

SECTION 846 – LOOP DETECTOR

846.01 Description. Furnish and install loop detectors, in accordance with the Contract Documents and as directed by the Engineer.

846.02 Materials. Provide Materials as specified in:

Loop Detector	Section 1079
Conduit, Galvanized	Section 1062
Home-Run Cable	Section 832
Backer Rod, Closed Cell	Section 1043
Tape	Section 1074
Heat Shrink Tubing	Section 1074

A. 1-1/2 inch galvanized rigid metal conduit – meets National Electric Code Section 344, UL Safety Standards UL6 and ANSI C80.1

B. 1-conductor #14 AWG Cable in 1/4 inch Flexible Tubing – consists of cable preinstalled in a polyethylene (PE) plastic duct meeting IMSA 51-5, rated for 600 volts. Use a cable with a temperature tolerance range of at least -65 to 176 degrees Fahrenheit. The conductor is AWG #14 stranded copper. Outside diameter of the cable is 0.25 inches. Referred to as “loop wire”.

C. 2-conductor #14 AWG Aluminum Shielded Cable – See Section 832. Referred to as “home-run cable”.

D. Flexible embedding sealer – A two-component polyester loop sealant that is highly durable and remains permanently flexible. Use a loop sealant capable to withstand the corrosive effect of road salts, automotive fluids, jet fuel, gasoline and extreme weather conditions. Minimize the length a lane is closed using a loop sealant that features rapid chemical curing and has extreme adhesion to concrete and asphalt. A sealer accelerant or retarder may be added per the manufacturer’s specifications.

E. Backer Rod – 5/8 inch closed cell foam

F. Tape – Use a vinyl electrical tape that has a PVC base with rubber based pressure sensitive adhesive, a minimum of 7 mils thick and UL listed and marked per UL Standard 510 as flame retardant and cold resistant. Use a tape compatible with synthetic cable insulations, jackets and splicing compounds and rated for wire and cable splices up to 600-volts.

G. For splices in Junction Well (see Standard Construction Details):

1. Dual Wall Heat Shrink Tubing – Use a heat-shrink tubing that is a medium or heavy wall thickness, irradiated polyolefin tubing containing an adhesive mastic inner wall. Minimum wall thickness prior to contraction of 40 mils. When heated, the inner wall melts and fills all crevices and interstices of the object being covered while the outer wall shrinks to form a waterproof insulation. Provide an overlap of the conductor insulation at least 1-1/2inches at each end of the heat-shrink tube or the open end of the end cap of heat-shrink tubing after contraction. Provide heat-shrink tubing that conforms to the requirements in and ANSI C119.1, for extruded insulated tubing at 600 volts.

2. Soldering iron with Rosin Core solder

3. Splicing kit – In-line barrel type design, resin encapsulating compound kit with UL486 rating. Suitable for use in wet or direct buried locations. Resin encapsulating compounds shall be acceptable for use at 61 degrees Fahrenheit.

846.03 Construction.

846.03.1 Loop Wire Installation.

Saw cut a groove into the pavement that is 5/8 inch wide and up to 3-1/2 inches deep. Perform the saw cut as a "wet-cut" and in the directions and sizes specified in the Contract Documents. Remove sharp edges in the saw cut and round the corners. Blow out the saw cut with compressed air to remove all dust, water and particles of loose Material prior to sealing.

Install the loop detector wire using blunt tools so as to prevent damage to the polyethylene outer cover. Tag one end of a loop detector wire to indicate start ("S"). Place a 5/8 inch backer rod on top of the wire in the saw cut as needed to secure the wiring within the saw cut. The Engineer may require a High Voltage Ground Test with a 500 volts DC megger after the loop detector installation is complete and prior to sealing saw cuts. If the resistance to ground is less than 100 megaohms, remedy the Work.

Apply a sealer and sealer accelerant or retarder (if necessary) in the saw cut in accordance with the manufacturer's directions and protect saw cut area from traffic until it has set. Install a minimum of 1 inch of sealer on top of the loop detector wire and finish flush with the pavement. Seal any drilled holes in the pavement.

Install two loop detector wires in a saw cut from the loop to the edge of the road. Extend these two wires from the end of the saw cut to a junction well. Twist the wires a minimum of 5 wraps per foot in a parallel direction, and tape every 12 inches to 18 inches from the end of the saw cut to a junction well up to the splice. Where the junction well is directly behind the edge-of-pavement, curb or sidewalk, bore a 1-1/2 inch rotary drill hole between the edge-of-pavement, curb or sidewalk and the junction well as shown in the Contract Documents. Install loop detector lead-in wire through the rotary drill hole into the junction well and splice accordingly. Where the junction well is set farther away from the edge of pavement, usually on the backside of a grass buffer, install a length of 1-1/2 inch galvanized rigid metal conduit and weatherproof fitting between the rotary drill hole and junction well in accordance with the Contract Documents. Install the loop detector lead-in wire through the rotary drill hole, 1-1/2 inch conduit and junction well and splice accordingly.

Install the loop detector wire in a continuous manner and without splices from the junction well, through the saw cuts and through the conduit.

846.03.2 Home-run Wire Installation.

Refer to Sections 831 and 832 for cable installation and conduit installation specifications. Refer to the Contract Documents for details.

846.03.3 Splicing.

Complete splices between the loop detector wire and home-run cable in accordance with the Contract Documents. Place conductors to be soldered side-by-side with the exposed copper aligned. Twist the copper clockwise to achieve a mechanical connection. Coat the splice with flux, heat with a soldering iron and rosin core solder in a manner that minimizes insulation damage. Insulate each soldered connection with heat-shrink tubing.

Test to ensure that all circuits are complete after the electrical and mechanical connection is completed and before the splicing kit is installed. Install an approved splice kit in accordance with the manufacturer's instructions. The Department will perform a continuity test at the cabinet after the splicing kit is applied. Remake the splice and/or loop at no cost to the Department if the continuity test fails.

Remake the splice at no cost to the Department if that splice becomes faulty within 90 Calendar Days of installation. The Department's ITS Technician will make the determination if the splice is not water tight or if the wires are crossed or mislabeled.

846.04 Method of Measurement

Measure the quantity of loop detector wire as the number of linear feet of saw cut in which loop detector wire is installed, sealed, complete in place and accepted. The length of loop wire installed between the saw cut and the junction well is included in this measurement.

Measure the quantity of 1-1/2 inch conduit installed as the number of linear feet of conduit installed, complete in place and accepted.

Conduit and associated home-run cable between the junction well and cabinet will be measured for under their respective Items.

846.05 Basis of Payment.

The quantity of loop detector wire supplied, installed, sealed, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
846001	FURNISH & INSTALL LOOP WIRE 1-CONDUCTOR #14 AWG ENCASED IN 1/4" FLEXIBLE TUBING IN A LOOP SAWCUT	LF

Price and payment constitute full compensation for "wet" sawcutting, furnishing and placing all Materials including loop detector wire, backer rod, sealer, sealer accelerant or retarder and for all labor, Equipment, tools, splicing in the junction well and incidentals necessary to complete this Item as specified and as directed by the Engineer.

The quantity of 1-1/2 inch galvanized rigid metal conduit detector sleeve with loop wire furnished, installed, complete in place and accepted will be paid at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
846002	FURNISH & INSTALL A 1-1/2-INCH GALVANIZED RIGID METAL CONDUIT DETECTOR SLEEVE WITH LOOP WIRE	LF

Price and payment constitute full compensation for furnishing and installing the galvanized rigid metal conduit, drilling required for installation, concrete and/or pavement patching, sealing the conduit ends, internal bushings shown in the Contract Documents and all hardware, labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

SECTION 847 –LIGHTING CONTROL CABINETS

847.01 Description. Furnish and install lighting control cabinets in accordance with the Contract Documents and as directed by the Engineer.

847.02 Materials. Provide Materials as specified in:

Lighting Control Cabinets	Section 1080

847.03 Construction.

A. Type M and Type R Cabinets

1. Furnish and install all Equipment necessary to provide a complete functioning lighting control cabinet as specified.
2. Mount cabinets on concrete base.
    a. Place a bead of sealant under the cabinet on three sides.
        i. Do not seal side with the lowest elevation to provide drainage from within the cabinet.
    b. Coat bolts with anti-seize compound.
    c. Bolt cabinet to base.
    d. Place a bead of sealant on the outside of the cabinet on the same three sides as in 847.03.2.a.(i), above.
3. Install photoelectrical control on the side or back of the lighting control cabinet using an LB conduit fitting. After installing the photoelectrical control and LB conduit fitting, seal the area around the hole in the cabinet so that the cabinet is watertight.

847.04 Method of Measurement. The quantity of lighting control cabinets will be measured as the number of cabinets furnished and installed in accordance with the Contract Documents, complete, and accepted.

847.05 Basis of Payment.

The quantity of lighting control cabinets furnished will be paid at the Contract Unit Price per each, in accordance with the Contract Documents. Price and payment constitute full compensation for furnishing all Materials, including cabinet enclosure, photoelectric control, circuit breakers, contactors, relays, arresters, panel boards, fans, combination thermostat/humidistat, and all labor, Equipment, tools, and incidentals required to complete the Work.

The quantity of lighting control cabinets installed on a pole, post mounted or on an existing cabinet base will be paid at the Contract Unit Price per each, in accordance with the Contract Documents, complete-in-place and accepted. Price and payment constitute full compensation for installing the cabinet on an existing pole, post mount or concrete base, sealant, anti-seize compound and all labor, Equipment, tools and incidentals required to complete the Work as specified and as directed by the Engineer.

ITEM	DESCRIPTION	UNIT
847001	INSTALL OR REMOVAL OF POLE OR POST MOUNTED CABINET	EACH
847002	INSTALL OR REMOVAL BASE OR PAD MOUNTED CABINET	EACH
847003	LIGHTING CONTROL CABINET – 200 A, 277/480V	EACH
847004	LIGHTING CONTROL AND DISTRIBUTION ENCLOSURE (120/240; 100 AMP)	EACH
847005	LIGHTING CONTROL CABINET – 60 A	EACH
847006	LIGHTING CONTROL CABINET – 100 A	EACH
847007	LIGHTING CONTROL CABINET – 200 A, 240/480V	EACH

SECTION 850 – LUMINAIRE

850.01 Description. Furnish and install or remove luminaire in accordance with the Contract Documents and as directed by the Engineer.

850.02 Materials. Provide Materials as specified in:

A. Cobra-Head Luminaire:

1. Furnish luminaire with wattage, lamp type and distribution type as noted in the Contract Documents.

   a. Submit catalog cuts, shop drawings and manufacturer's specifications to the Engineer for approval.

   b. Submit the photometric file for the luminaire selected, in standard IES electronic format. Clearly indicate the name of the file on the shop drawing.

   c. UL listed luminaire is equipped with lamp, photo cell and shorting cap as required in the Contract Documents, multi-voltage ballast, connector kit, 1-1/4 inch to 2 inch slip fitter, and bird guard.

   d. Die cast aluminum housing with optical assembly and removable door.

   e. Door to have integral hinges, made of non-corrodible Material, for hands-free installation, re-lamping and maintenance.

   f. Ensure the optical assembly includes an aluminum reflector with a heat/impact-resistant tempered sag glass lens or acrylic or polycarbonate resin clear globe.

   g. Ensure the refractor door is sealed with an appropriate gasket to make the optical system dust-tight.

   h. Ensure the refractor door latch, constructed of non-corrodible Material, is sized to enable easy handling. Ensure the latch produces an audible "click" when locked.

   i. Equipped with ventilating channel, with charcoal filter.

   j. Ballast mounted on the removable mounting door and connected to the luminaire electrically through a quick disconnect plug.

   k. Ensure that 2 bolt slip fitter is suitable for mounting on 1-1/4 inch to 2-inch mounting arm.

   l. Ensure the luminaire leveling pad is capable of adjusting plus or minus 3 degrees for proper leveling.

B. Underpass Luminaire:

1. Furnish luminaire with wattage, lamp type and distribution type as noted in the Contract Documents.

   a. Submit catalog cuts, shop drawings and manufacturer's specifications to the Engineer for approval.

   b. Submit the photometric file for the luminaire selected, in standard IES electronic format. Clearly indicate the name of the file on the shop drawing.

   c. Provide luminaire which is listed as suitable for wet locations according to UL Standard No. 1572 with sealed and filtered optical assemblies; lamp socket has heavy-duty mogul base with split shell tempered brass lamp grips and a free-floating, spring-loaded center contact.

   d. Cast aluminum housing, painted with premium quality gray or dark bronze paint.

   e. Prewired ballast and terminal board assembly, and cast aluminum single-hinged door with glass refractor.

   f. Formed aluminum reflector and socket assembly with a chemically bonded lightweight non-breakable glass finish, removable only by screwdriver.

   g. Factory installed mounting holes in the back and conduit entrances in the sides and top.

C. High Mast Luminaire

1. Provide luminaire with wattage, lamp type and distribution type as noted in the Contract Documents.
    a. Submit catalog cuts, shop drawings and manufacturer's specifications to the Engineer for approval.
    b. Submit the photometric file for the luminaire selected, in standard IES electronic format. Clearly indicate the name of the file on the shop drawing.
    c. Provide fixture having a natural aluminum finish or painted light gray.
    d. Provide luminaire that has housing formed, cast, or drawn from low copper aluminum, free of cracks and excessive porosity, with all seams welded.
    e. Luminaire identification labels are not required.
    f. Construct the reflector housing separate from the fixture reflector.
    g. Provide slip fitter that will securely attach fixture to the tenon and ring assembly with a minimum of two bolts and clamp.
    h. Provide lens of tempered or prismatic glass, with sag.
    i. Ensure optical compartment is water and dust tight.
    j. Provide UL listed mogul base lamp sockets rated for 600 volt, 1500 watt that can withstand a 5000 volt pulse.
    k. Provide multi-voltage ballast, designed to operate a 750 watt or 1000 watt HPS lamp at 277 volts.

D. Luminaire and Lamp characteristics will be as follows:

TYPES	WATTS	INITIAL LUMENS	RATED LIFE (10 hr/start)
HPS	70	6,400	24,000
	100	9,500	
	150	16,000	
	200	22,000	
	250	28,000	
	400	50,000	
	750	110,000	
	1000	140,000	

E. Photoelectric Controls

1. If Contract Documents require a photocell on the cabinet for the entire lighting system, omit the photocell on the individual luminaires.
2. Provide Photoelectric Control with solid state, cadmium sulfide type with hermetically sealed silicone rectifier rated 120volt, 60 cycle AC and 1000 watts maximum load.
3. Ensure a built in surge protection and fail safe operating feature is included, so the lighting circuits remain energized in the event the photo control components become inoperative.
4. Ensure the nominal operating levels turn on photo control at a minimum vertical illumination value of 3 footcandles and turn off at a maximum vertical illumination value of 6 footcandles.
5. Ensure the photo control is twist lock type, with suitable mounting bracket with locking type receptacle.

All electrical Materials shall conform to the requirements of the National Electrical Code of the National Fire Protection Association, and to all local and state laws and/ordinances governing such installations.

850.03 Construction.

A. Cobra-Head Luminaire

1. Install luminaire in accordance with the manufacturer's installation instructions and as directed by the Engineer.
2. Install luminaire identification decals, in accordance with NEMA conventions, to the housing.
3. Ensure the decal is readily visible from the ground and meets the following requirements:
    a. Solid Yellow "07", "10", "15", "25", and "40" will correspond to 70,100, 150, 250, and 400 watts high pressure sodium lamps, respectively.
4. Adjust luminaire on the slip fitter to provide maximum light on the surface to be illuminated.
5. Check luminaires for proper positioning and level and perform an illumination test.

B. Underpass Luminaire

1. Install underpass luminaire in accordance with the manufacturer's installation instructions and as directed by the Engineer.
2. Adjust socket positions to provide the required photometric performance.
3. Install luminaire identification decals, in accordance with NEMA conventions, to the housing.
    a. Ensure the decal is readily visible from the ground and meets the following requirements:
        i. Solid Yellow "07", "10", and "15" will correspond to 70, 100, and 150 watts high pressure sodium lamps, respectively.
4. Mark the month and year the lamp is installed on the lamp base dating system with sharp instrument.
5. Check luminaires for proper positioning and level and perform an illumination test.

C. High Mast Luminaire

1. Install high mast luminaire in accordance with the manufacturer's installation instructions and as directed by the Engineer.
2. Mark the month and year the lamp is installed on the lamp base dating system with sharp instrument.
3. Check luminaires for proper positioning and level and perform an illumination test.

D. Removal of Existing Luminaire

1. Remove the luminaire from the pole or davit arm after the wires have been disconnected.
2. Tape and secure the wires so that they remain available for installation of a luminaire.
3. Store the luminaire in a secure location on the Project site if it is to be re-installed in a new location.

850.04 Method of Measurement.

A. Luminaire

1. The quantity of luminaires will be measured as the actual number of luminaires furnished, installed, complete in place and accepted.

B. Removal of Luminaire

1. The quantity of luminaires removed will be measured as the actual number of luminaires removed and accepted.

850.05 Basis of Payment.

A. Luminaire

1. Price and payment constitute full compensation for furnishing and installing all Materials, including lamps, luminaires, ballasts, photoelectric control, luminaire identification stickers, submitting

photometric data, and for all labor, tools, Equipment, and incidentals necessary to complete the Item installation as specified and as directed by the Engineer.

B. Removal of Luminaire

1. Price and payment constitute full compensation for removing the existing luminaire, taping and securing existing conductors, storing the luminaire for future re-installation and for all labor, tools, Equipment and incidentals necessary to complete the Item as specified and as directed by the Engineer.

C. Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
850001	LUMINAIRE (HPS), 70 WATTS	EACH
850002	LUMINAIRE (HPS), 100 WATTS	EACH
850003	LUMINAIRE (HPS), 150 WATTS	EACH
850004	LUMINAIRE (HPS), 250 WATTS	EACH
850005	LUMINAIRE (HPS), 400 WATTS	EACH
850006	LUMINAIRE (HPS), 750 WATTS	EACH
850007	LUMINAIRE (HPS), 1000 WATTS	EACH
850008	UNDERPASS LUMINAIRE (HPS), 70 WATTS	EACH
850009	UNDERPASS LUMINAIRE (HPS), 100 WATTS	EACH
850010	UNDERPASS LUMINAIRE (HPS), 150 WATTS	EACH
850011	REMOVAL OF LUMINAIRE	EACH

SECTION 851 – ALUMINUM LIGHTING STANDARD

851.01 Description. Furnish and install or relocate aluminum lighting standard with single or double Davit arm and breakaway transformer base in accordance with the Contract Documents and as directed by the Engineer.

851.02 Materials. Provide Materials as specified in:

Anchor Bolts, Galvanized	Section 1039
Hardware, lighting standard, stainless steel	Section 1044
Lighting Pole and Davit Arm, aluminum alloy 6063-T6	Section 1062
Submit catalog cuts, drawings and manufacturer's specifications for approval	
Conduit	Section 1062
Aluminum Castings, alloy 356-T6	Section 1044
Anchor Base Plate, aluminum alloy 6000 series	Section 1044
Pole ID Tag, clear anodized 1/16" thick aluminum	
Transformer Base, 356-T6 Cast Aluminum Alloy	
Breakaway in accordance with NCHRP 350 or MASH Submit FHWA eligibility letter to Engineer for approval	
Submersible Breakaway Connector Kits	Section 832 or 1074
H-Taps, C-taps, Butt Splices	Section 832 or 1074
Welding, Aluminum	Section 1044

All electrical materials shall conform to the requirements of the National Electrical Code of the National Fire Protection Association, and to all local and special laws and/ordinances governing such installations.

851.03 Construction.

A. Lighting Standard
   1. Provide lighting standard Meeting or exceeding the requirements of the latest edition of the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals".
      a. Submit computations, signed and sealed by a professional engineer licensed in the State of Delaware, in conformance with AASHTO specifications with year of the edition specified.
   2. Ensure the pole consists of tapered aluminum shaft, with a base welded to the lower end.
   3. Ensure the pole shaft, pole extensions, and Davit arms spun from one piece of seamless tubing.
      a. Ensure the shaft contains internal vibration dampening device positioned approximately 2/3 the height of the pole.
   4. Ensure the Strut and Arm plates are extruded.
   5. Install permanent pole ID tag, with smooth edges, rounded corners, to fit light pole shaft.
      a. Secure tag to shaft using four (4) 1/8 inch diameter 18-8 stainless steel round head drive screws or self-tapping screws.
      b. Provide tag displaying information (embossed) in accordance with the Contract Documents.
   6. Install lighting Structure with bracket arms set perpendicular to the edge of the roadway, unless otherwise noted in the Contract Documents.

B. Davit Arm
   1. Ensure the bracket arm is Davit type, and length and type (single or double) is as specified in the Contract Documents.
      a. Drill light pole with two lockbolts to secure Davit arm bracket to light pole shaft.
      b. Slip Davit arm over top of the light pole shaft.

c. Ensure the luminaire end of Davit arm is fitted with a 2 inch NPS aluminum pipe tenon.

C. Transformer Base
1. Install transformer base per the Contract Documents.
2. Splice lighting cables in transformer base using submersible breakaway connector kits, to #10 AWG wires connected to luminaire.
   a. If spliced, “Pass-through” circuits are spliced using H-taps, C-taps or butt splices
3. Install opening of access door on the side of the pole facing away from traffic.
4. Install Anchor Bolts per Section 834.

D. Relocation of Lighting Standard and Davit arm
1. Remove the luminaire from the lighting standard in accordance with Section 850 and store the luminaire in a secure place to prevent damage.
2. Remove existing lighting standard, transformer base and Davit arm as one unit from the existing pole base and relocate to the designated pole base and re-install in accordance with this Section.
3. Re-install luminaire in accordance with Section 850.
4. Should any damage occur to the luminaire, lighting standard, Davit arm and/or transformer base during the relocation operation, replace the damaged assembly in kind at no cost to the Department.

851.04 Method of Measurement.

A. Lighting Standard and Davit Arm
1. The quantity of aluminum lighting standards with Davit arms and transformer bases of the size specified will be measured as the actual number furnished, assembled, installed and accepted.

B. Relocation of Lighting Standard and Davit Arm
1. The quantity of lighting standards with Davit arm and transformer base relocated will be measured as the actual number relocated, complete-in-place and accepted.

851.05 Basis of Payment.

A. Lighting Standard and Davit Arm
1. The quantity of lighting standards will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for furnishing, assembling and installing aluminum lighting standard, single or double Davit arm and transformer base and for all materials including labor, Equipment, hardware, pole, ID tags, flush joint, gusset plate, and incidentals necessary to complete the Work, included in the Items listed below as specified and as directed by the Engineer.

B. Relocation of Lighting Standard and Davit Arm
1. The quantity of lighting standards relocated will be paid at the Contract Unit Price per each. Price and payment constitute full compensation for removing and reinstalling existing luminaires, relocated existing lighting standard, Davit arm and transformer base and for all labor, Equipment, hardware, splice/connector kits, and incidentals necessary to complete the Work as specified and as directed by the Engineer.

Payment will be made for accepted quantities at the Contract Unit Price as follows:

ITEM	DESCRIPTION	UNIT
851001	ALUMINUM LIGHTING STANDARD WITH SINGLE DAVIT ARM, 30’ POLE	EACH
851002	ALUMINUM LIGHTING STANDARD WITH SINGLE DAVIT ARM, 35’ POLE	EACH
851003	ALUMINUM LIGHTING STANDARD WITH SINGLE DAVIT ARM, 40’ POLE	EACH
851004	ALUMINUM LIGHTING STANDARD WITH DOUBLE DAVIT ARM, 30’ POLE	EACH
851005	ALUMINUM LIGHTING STANDARD WITH DOUBLE DAVIT ARM, 35’ POLE	EACH
851006	ALUMINUM LIGHTING STANDARD WITH DOUBLE DAVIT ARM, 40’ POLE	EACH
851007	RELOCATED EXISTING LIGHT STANDARD	EACH

DIVISION 900 – EROSION, SEDIMENT AND STORMWATER MEASURES

SECTION 901 – EROSION, SEDIMENT AND STORMWATER MANAGEMENT

901.01 Description. Implement all Erosion and Sediment Control and Stormwater Management practices and techniques in accordance with the regulations, permits, policies, and procedures applicable to all DelDOT Contracts, and as directed by the Engineer.

901.01.1 Definitions.

Concrete Washout. A concrete washout is a designated area to capture any effluent generated from washing out the mixing drum or the associated parts of a concrete delivery system, including, but not limited to, chutes, excess concrete and discharge hoses.

Construction Debris. Construction debris is any refuse generated within the Project limits to include but not limited to packaging materials, scrap construction materials (i.e. geotextiles, lumber, excess asphalt, etc.), timber, pipe and electrical cuttings, plastics, styrofoam, concrete and other trash or building materials. All construction debris is waste material.

Disturbed Area. Disturbed area is an area where land disturbing activities have been initiated which may result in soil erosion. Examples include, but are not limited to, clearing, grubbing, grading, excavating, transporting, filling, and backfilling of land.

Erosion, Sediment and Stormwater Management (ES2M) *Inspections*. Inspections are compliance inspections of the project site, completed by the ES2M CCR. The inspection is used to complete the ES2M Inspection Rating Form.

ES2M Certified Construction Site Reviewer (CCR). A Certified Construction Reviewer (CCR) is an inspector of sediment and stormwater controls on DelDOT administered construction sites.

For Minor Projects: This position will be assigned by the Engineer with the following responsibilities.

A. Perform weekly ES2M Inspections and document observed deficiencies, directives for correction with due dates & timely completion thereof within the DelDOT Construction Diary. These will be available for review by the Engineer.

For Medium and Major Projects, this position will be assigned by the Stormwater Engineer with the following responsibilities.

A. Schedule and attend an ES2M Pre-Construction Meeting on site, which is a separate meeting from the Project Pre-Construction meeting, a minimum of 7 days prior to the Notice to Proceed. Review approved ES2M plan with the contractor and the DelDOT Project Resident. Discuss any proposed plan changes at this time. Document the meeting within 3 days of occurrence and distribute to attendees and other designated DelDOT personnel.

B. Perform weekly ES2M Inspections and submit reports to the Stormwater Section.

C. Perform SWM construction checklist and submit checklist to the Stormwater Section.

Hazardous Materials. Hazardous materials is any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors.

Secondary Containment. Secondary containment provides an essential line of defense in the event of a failure of the primary containment system.

Sediment and Stormwater Management Plan. A Sediment and Stormwater Management Plan is the plan contained in the Contract Documents describing the control of soil erosion, sedimentation, stormwater quantity, and water quality impacts resulting from land disturbing activities arising from the Project.

Waters of the United States. As defined in Clean Water Act, 40 CFR 230.3(o) definitions and/or the most updated

version of that definition.

901.02 Materials. Not applicable.

901.03 Construction.

901.03.1 Legal Authority. Any Contractor performing Work for the Department is required to maintain compliance with the Delaware Sediment and Stormwater Regulations (DSSR) and the NPDES General Permit Program for Stormwater Discharges Associated with Construction Activities. The Department will ensure that all Contractors comply with the DSSR by enforcing the regulations through the terms of the Contract. As an owner, DelDOT must comply with Chapter 60 of Title 7 of the Delaware Code Section 9.1.02 of Delaware's Regulations Governing the Control of Water Pollution, 7 DE Admin. Code 7201.

901.03.2 Sediment and Stormwater Management Plan Approval. A signature and date in the Stormwater Engineer's block on the title sheet of the Plans indicate that the Plans were designed in conformance with the DSSR and that the Sediment and Stormwater Management Plan is approved.

Neither review nor approval by the Engineer, nor errors and omissions in the Contract Documents, or Contract Documents as amended, shall relieve the Contractor from its responsibilities for compliance with the Delaware Sediment and Stormwater Regulations.

901.03.3 Inspection. The ES2M Certified Construction Site Reviewer (CCR) will complete the Erosion Sediment and Stormwater Management (ES2M) Inspection Rating Form.

A. For Minor Projects: The position of the ES2M CCR will be assigned by the Engineer with the following responsibilities.

   1. Perform weekly ES2M Inspections and document observed deficiencies, directives for correction with due dates & timely completion thereof within the DelDOT Construction Diary. These will be available for review by the Engineer.

B. For Medium and Major Projects: The position of the ES2M CCR will be assigned by the Engineer with the following responsibilities.

   1. Schedule and attend an ES2M Pre-Construction Meeting on site, which is a separate meeting from the Project Pre-Construction meeting, a minimum of 7 Days prior to the Notice to Proceed. Review approved ES2M plan with the Contractor and the DelDOT Project Resident. Discuss any proposed plan changes at this time. Document the meeting within 3 Days of occurrence and distribute to attendees and other designated DelDOT personnel.

   2. Perform weekly ES2M Inspections and submit reports to the Department's Stormwater Section.

   3. Perform SWM construction checklist and submit checklist to the Department's Stormwater Section.

901.03.4 Division of Responsibility. The Contractor Erosion & Sediment Control Supervisor (Contractor ESC Supervisor) will have the following responsibilities:

A. Will be considered the Responsible Personnel for all land disturbing activities and be limited to two individuals on the Contractor's Staff.

B. Will have authority to direct and complete the Work needed to comply with the approved Sediment and Stormwater Management Plan and to correct any deficiencies listed on the Erosion Sediment and Stormwater Management (ES2M) Inspection Rating Report

C. Will accompany the ES2M CCR on weekly ES2M Inspections, on medium and major projects, and sign and date in receipt of these reports.

D. Will implement and maintain the approved Sediment and Stormwater Management Plan.

E. Will attend the Erosion & Sediment Pre-Construction Meeting. Will exchange emergency numbers with the Engineer and provide a photo copy of his/her valid DNREC Certification.

In addition to A thru E above, for Minor and Medium Projects the Contractor ESC Supervisor will possess and

maintain a Contractor Blue Card for the life of the project.

In addition to A thru E above for Major Projects, the Contractor ESC Supervisor will possess and maintain a CCR Card for the life of the project.

901.03.5 Failure to Implement and Maintain Erosion and Sediment Control Measures

Maintain erosion and sediment control items continuously throughout the duration of the project, including periods when the project is inactive or suspended. Repair, replace, or maintain any erosion and sediment control device promptly as noted on the ES2M Inspection Rating Report or as directed by the Engineer. Stabilize any eroded surface and remove and dispose of any accumulated sediment not trapped by a control measure in an approved stockpile area or haul off-site. Maintain access to all sediment control devices until construction phasing and stabilization allow the removal of those controls. Based on the ES2M Inspection Rating Report form the following will happen:

Points Awarded	**Actions to be taken**
69.9-60.0	- A follow-up inspection will be required in 2 working days to evaluate correction of deficiencies. - If the follow-up inspection is still within this point range, the Engineer will take any or all actions below to gain compliance.
59.9-0	- A follow-up inspection will be required in 2 working days to evaluate correction of deficiencies. - If the follow –up inspection is still within this point range, the Engineer will proceed directly to 901.06 C.

If, at any time, the Contractor fails to perform the work as directed by the approved Sediment and Stormwater Management Plan, the ES2M Rating Report, or in writing from the Engineer, the Engineer will take any or all of the following actions listed below to gain compliance.

A. Limited Suspension of Activity. The Engineer will order a "Limited Suspension of Activity" for the specific land disturbing activities that are not in compliance. Activities necessary to bring the site into compliance will be permitted. Time charges will continue during a Limited Suspension of Activity. No new land disturbance can take place during this time period.

B. Withhold Progress Payments. The Engineer will withhold monthly estimate payments for all Contract Items until E&S deficiencies are corrected.

C. Stop Work Order. The Engineer will suspend the performance of all construction, as noted in Section 105.02, for a maximum of 10 Days to bring the ES2M Inspection Rating Report to a 70 or above. If, after the 10 calendar Days the ES2M Inspection Rating Report is still below a 70, the Engineer will proceed to 901.06.D.

D. Time charges will continue during this “Shut-Down” period and no claims for additional time or money shall be allowed due to "Shut-Downs" resulting from the Contractor's failure to implement and maintain the required erosion and sediment control Items.

E. Deduct Cost of Work Completed By Others. The Engineer will proceed with adequate forces and equipment of its own or a third party contractor to implement or maintain the erosion and sediment control items necessary to bring the Project into compliance with the approved Sediment and Stormwater Management Plan.

The entire cost to engage either a third party contractor or the Department’s Maintenance personnel, including administration costs, will be deducted from monies due the Contractor.

901.03.6 Fines Resulting from Non-Compliance

If the Department receives any fines from DNREC, the Army Corps of Engineers or the EPA as a direct result of the Contractor's refusal to implement and maintain the approved Sediment and Stormwater Management Plan, failure to supply a Contractor

ESC Supervisor, or failure to correct deficiencies identified in the ES2M Inspection Rating Report, the Contractor will be responsible to pay the fines or the money will be deducted from monies due the contractor.

901.04 Method of Measurement. This Item will not be measured.

901.05 Basis of Payment. All costs associated with the provisions above are incidental to the Contract.

SECTION 902 – PUMPING OPERATIONS

902.01 Description. Furnish necessary Equipment, Materials, and labor to dewater locations shown on the Plans, and as directed by the Engineer.

A. *Statewide General Permit for Minor Dewatering Activities.* Comply with the Statewide General Permit issued to the Department by DNREC via interagency Memorandum of Agreement. Covered Work includes the following activities:

1. *Dewatering*. Dewater the work area in accordance with this specification at rates less than 50,000 gallons per day.

2. *Stream By-pass Pumping.* By-pass surface water to facilitate in-stream work for bridge and culvert replacements. By-pass pumping at rates exceeding 50,000 gallons per day are permitted provided no water is withdrawn for consumptive use and all water is returned to its natural course immediately downstream of the work area.

B. *Permits Required.* Obtain a separate dewatering permit from DNREC when groundwater or surface water withdrawal rates in excess of 50,000 gallons per day are necessary.

1. *Permit Acquisition.* Obtain all necessary permits for dewatering and disposal of pumped water required to construct and complete the Work from DNREC, Division of Water, Water Supply Section, unless covered in the Statewide General Permit for Minor Dewatering Activities.

2. *Permit Costs.* Pay all costs associated with the acquisition of separate dewatering permits from DNREC.

3. *Permit Acquisition Time.* Dewatering permits for rates exceeding 1,000,000 gallons per day require public notice and possibly a public hearing before DNREC will issue a permit. Ensure that sufficient permit acquisition time is included in the Project Schedule to obtain the permit. Time extensions will not be granted for failure to account for this time in the Project Schedule.

4. *Other Permits.* State and Federal permits are required for any entry into streams or wetlands. Environmental Requirements are more fully described in the Project Environmental Statement.

   The Statewide General Permit for Minor Dewatering Activities does not constitute approval, exemption or waiver from any other law, rule or regulation that may apply to the work shown in the Plans or the activities necessary to complete the Work. (See Specification Section 107.02, Permits, Licenses and Taxes.)

5. *Licensing Requirements.* Meet any and all DNREC licensing requirements for the installation or operation of the dewatering Equipment, or employ the services of properly licensed subcontractors such as a well driller when an individual dewatering permit is required.

902.02 Material. Provide Materials as necessary and required.

902.03 Construction. *Submit Approved Permits.* Submit copies of all permit approvals to the Engineer. Dewatering operation cannot begin until the necessary dewatering permit is submitted to the Engineer.

A. *Dewatering Equipment.* Provide sufficient Equipment and back-up or replacement Equipment necessary to ensure the continuous dewatering of the work area. Instantaneous and totalizing flow meters, accurate to within +/- 5 percent, are required on all dewatering Equipment.

B. *Required Notifications.* Notify the DNREC Water Supply Section at (302) 739-9945, 48 hours prior to starting any dewatering operations.

   Notify DNREC Wetlands and Subaqueous Lands Section at 302-739-9943, 48 hours prior to starting any dewatering adjacent to wetlands or if discharge water is proposed to be directed to any wetlands.

C. *Dewatering Operation.* Do not allow surface and ground water to rise around the proposed Work. Continue dewatering until the Work has been brought to finished lines and grades, and accepted by the Engineer. None of the proposed Work shown on the Plans will be laid in water, unless otherwise indicated on the Plans or directed by the Engineer.

D. *Protection of Work Area.* Install clean water diversions outside excavation limits to prevent the flow of surface water from undisturbed areas into open excavations using any combination of berms, pipes, dikes, pumps, etc. in order to establish a clean water diversion. Comply with applicable sediment control measures.

E. *Protect Adjacent Property.* Dispose of pumped water into a suitable conveyance system without flooding or damage to adjacent property, buildings, Structures, utilities, and other Work. Protect adjacent Structures and property from any damage that may occur as a result of settlement or other effects related to the removal of ground water and lowering of the water table. Do not drain dewatering discharge into Work completed or under construction without prior consent of the Engineer. Dispose of water in such a manner as not to be a menace to the Public Health. Discharging to the sanitary sewer system is not permitted.

F. *Protect Adjacent Waterbodies.* Discharge of saline water into a fresh water system or discharge fresh water into a saline water system is prohibited. Dewatering operations for the Project cannot cause the inadvertent drawdown or dewatering of wetlands or other surface water bodies.

G. *Dewatering Discharge.* Ensure all discharges are directed to sediment trapping or filtering devices such as a dewatering bag, dewatering basin, portable sediment tank, sediment trap or sediment basin prior to release into ditches, storm drain systems, streams or surface water bodies of any type.

H. *Dewatering of Temporary Cofferdams for Bridge Construction.* Upon completion of driving of temporary sheet pile for in–stream Work, or erection of a temporary dike to create a temporary cofferdam, leave the sediment-laden water within the cofferdam undisturbed for a minimum of 12-hours to allow settling of suspended soil particles. Remove water from temporary cofferdams by skimming it off the surface. Immerse intake no more than 6 inches below the water surface. Once the water level has been pumped down, accomplish additional dewatering using a sump pit constructed in conformance with DelDOT Standard Construction Details. Any deviation from Standard Construction Details requires prior approval and may require an individual dewatering permit from DNREC.

I. *Well Impacts.* As required by Title 7, Del.C., §6031 and §6037, take whatever steps are necessary to provide continuous uninterrupted water service to any affected public or private potable water supplies or wells within the Project area if adversely affected by the dewatering operations associated with this Project.

902.04 Method of Measurement. Dewatering Operations will not be separately measured.

902.05 Basis of Payment. Dewatering Operations will not be separately paid. All costs are incidental to the associated Work Items.

SECTION 903 – POLLUTION PREVENTION

903.01. Description. Implement and maintain the Pollution Prevention Plan outlined in the Contract Documents using best management practices (BMPs) within the Project limits to identify pollution sources to minimize or eliminate potential pollutant impact.

903.02. Materials. Provide Materials as necessary and required.

903.03. Construction. Inspect and monitor each pollution prevention practice on a regular basis to eliminate and/or minimize the potential for spills and leaks, and maintain:

A. Waste Management Practices. Use the following construction methods for waste management practices:

1. *Waste-Collection*

   a. Designate and clearly mark a waste collection area within the LOC for locating a receptacle(s). Collect and store all waste material in the receptacles. Each receptacle shall have a cover available for installation at the end of each Work Day and/or during a weather event that produces stormwater runoff.

   b. Place receptacle(s) in a location away from inlets that drain to a water body.

   c. Empty receptacles a minimum of once every 20 Working Days or more as necessary. Stored Waste will not be allowed to exceed the capacity of the receptacle(s). Monitor the Project limits daily for waste material and pickup waste material as necessary.

   d. Dispose of waste material in accordance with all applicable Delaware laws.

2. *Sanitary Facilities*

   a. Provide proper sanitary facilities.

   b. Place sanitary facilities a minimum of 50 feet from storm drains and/or waterways.

B. Equipment and Vehicle Fueling and/or Maintenance Practices. Use the following construction methods for Equipment and vehicle fueling and/or maintenance practices:

1. Clearly mark designated areas for on-site fueling.

2. Have a spill kit readily available at the site of the fueling operation.

3. Use drip pans, drip cloths, or absorbent pads when replacing fluids, fueling or making emergency repairs.

4. Collect all spent fluids and store in appropriately labeled containers in properly covered storage areas. Recycle fluids whenever possible.

C. Dewatering Equipment. Use the following construction methods for dewatering Equipment.

1. When Equipment, including pumps, is used in dewatering operations located within the Waters of the United States, Secondary Containment is required.

2. Whenever possible, remove Equipment from the Waters of the United States at the end of each Day.

D. Designated Washout Areas**.** Use the following construction methods for designated washout areas.

1. Collect Concrete Washout in a temporary device for hardening and proper disposal as per Standard Construction Detail – Concrete Washout. Clearly mark designated disposal facilities.

2. Clearly mark designated Paint and Stucco washout. The device and/or constructed BMP require approval of the Engineer prior to using.

3. Locate washout facilities at least 50 feet from a storm drain and/or any waterways whenever possible. Locations require approval of the Engineer.

4. Regular inspection and maintenance of these areas is required.

E. Storage Facilities and Staging Areas. Use the following construction methods for storage facilities and staging areas.

1. Store all potential pollutants (paint, solvents, pesticides, fuels, oils, and other Hazardous Materials) under impermeable cover.
2. Fuel tanks above 250 gallons require Secondary Containment systems. Double-lined tanks meet the Secondary Containment requirement. If requested by the Engineer, provide information on the device detailing this specific requirement.
3. Designate staging areas for activities such as fueling, mixing paints, etc.

F. Equipment/Vehicle Washing

1. Clearly mark the wash area.
2. Ensure that all washing occurs only in the designated area.
3. Locate wash areas a minimum of 50 feet from a storm drain and/or waterway.
4. Do not use detergents to remove dirt.
5. Route wash water discharges to sanitary sewer whenever possible.

903.04. Method of Measurement. This Item will not be measured.

903.05 Basis of Payment. All costs associated with the provisions above are incidental to the Contract.

SECTION 905 – SEDIMENT TRAPPING DEVICES

905.01 Description. Trap sediment before it leaves the job site by using a type of silt fence, sediment traps or basins, a type of inlet protection or flocculation and other approved sediment trapping devices.

Sediment-Laden Runoff. Stormwater runoff from disturbed areas shall be directed to an approved sediment control measure, prior to release from the Project limits of construction as shown on the Plans, or as directed by the ES2M CCR and the Engineer.

905.02 Materials. Provide Materials for sediment trapping devices as specified below:

Seed	Section 908
Geotextile	Section 1060
Riprap	Section 1006
Stone; Delaware No. 3	Section 1004
Wood	Section 1041
Steel Posts	Section 1039

905.03 Construction. Use the following construction methods for sediment trapping devices:

A. *Silt Fence.* Construct, maintain and remove silt fence as follows:

1. *Construction of Silt Fence.* Construct silt fence as follows:

   a. Excavate the trench along the upstream side of the post line as shown on the Standard Construction Details.

   b. Install posts along the established fence line on the downstream edge of the trench.

   c. Securely attach the geotextile Material to the upstream side of the posts with fasteners and attachment.

   d. Install a reinforcement strip at the geotextile roll ends; overlap a minimum of 6 inches at post locations.

   e. Embed the geotextile in the excavated trench.

   f. Backfill and compact the trench over the geotextile

   g. On slopes, turn the terminal ends of silt fence upslope a sufficient distance to eliminate flow around the ends of the silt fence.

   h. Do not construct the silt fence across any ditch, swale, or any area of concentrated water flow.

2. *Construction of Reinforced Silt Fence.* Construct reinforced silt fence as follows:

   a. Construct according to Section 905.03A.1.

   b. Fasten wire mesh to the posts between the geotextile and the posts.

3. *Maintenance of Silt Fence.* Maintain silt fence as follows:

   a. Repair or replace all geotextile damaged at anytime during the life of the Contract.

   b. Replace all deteriorated or clogged geotextile.

   c. Periodically remove accumulated trash.

   d. Remove trapped sediment, when it reaches 50 percent of the exposed height of the fabric.

   e. After every heavy rainfall, check for and remove excessive buildup of sediment.

   f. Clean the geotextile of trapped sediment by lightly brushing the geotextile when dry.

4. *Removal of Silt Fence*. Remove silt fence as follows:

   a. Remove the silt fence and all Materials incidental to the silt fence construction when the Engineer determines that they are no longer required.

   b. Restore all areas affected by the construction of the silt fence to the original or Plan contours.

   c. Stabilize all areas affected by the construction of the silt fence.

B. *Sediment Trap.* Construct, maintain and remove sediment trap as follows:

   1. *Construction of Sediment Trap***.** Construct sediment trap as follows:

      a. Construct sediment traps by excavating to the dimensions and elevations indicated on the Plans and Standard Construction Detail, Sediment Trap.

      b. Stabilize the side slopes with temporary seed.

   c. If any sediment trap conflicts with the placement of permanent drainage pipes or ditch lines,

      i. First excavate the sediment trap to the dimensions and elevations shown on the Plans.

      ii. Then, place the proposed pipes and/or ditches when the sediment trap is no longer needed.

   d. Do not excavate sediment traps in excess of 4 feet deep. Excavate sediment traps having proposed bottom elevations greater than 4 feet lower than the original grade in stages concurrent with the roadway excavation.

   e. Mark the cleanout elevation on a stake driven into the ground at the bottom of the trap. The depth marked is one-half the design depth of the trap.

   f. All traps require an outfall that is incidental to the sediment trap Item as shown on the Plans.

1. *Maintenance of Sediment Trap***.** Maintain sediment trap as follows:

   a. Maintain the sediment trap to the original dimensions and function of the sediment trap.

   b. Inspect the sediment trap immediately after every rainfall and make repairs as needed.

   c. Remove accumulated sediment when depth has reached the cleanout elevation.

   d. Dispose of sediment properly.

   e. Restore trap to its plan dimensions and elevations.

2. *Removal of Sediment Trap*. Remove sediment trap as follows:

   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.

C. *Inlet Sediment Control***.** Construct, maintain and remove inlet sediment control as follows:

1. *Construction of Inlet Sediment Control.* Construct inlet sediment control as follows:

   Construct according to the type required and follow the applicable Standard Construction Details or manufacturers recommendations.

2. *Maintenance of Inlet Sediment Control.* Maintain inlet sediment control as follows:

   a. Remove accumulated sediment from inlet sediment control as soon as practicable, but within 48 hours, as directed by Engineer.

   b. Remove and replace as necessary based on product manufacturer's requirements or when sediments interfere with proper flow of water through the product.

   c. Do not deposit sediment within catch basins and / or associated pipes.

   d. Do not allow sediment discharges into bodies of water and/or wetlands State, Federal or privately owned.

e. Do not allow sediment discharges into ditches or swales.

3. *Removal of Inlet Sediment Control.*

Remove inlet sediment control and stabilize all areas affected by the construction of the inlet sediment control.

905.04 Measurement. The Engineer will measure the quantity of Work acceptable completed for sediment trapping devices as follows:

A. Silt fence and reinforced silt fence by the linear feet of fence placed and accepted exclusive of overlap(s).

B. Sediment traps as the actual number of cubic yards 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.

C. Inlet Sediment Control as each.

905.05 Payment. The quantity of Sediment Trapping Practices is paid for at the Contract Unit Price for each acceptably placed. Price and payment constitutes full compensation for furnishing all Materials, excavating and backfilling, installing, maintaining, (including sediment removal) and removal when no longer needed, for restoring the site, seeding, for all labor, tools, Equipment, and incidentals required to complete the Work.

Note: Maintenance of the Sediment Trapping Devices will not be measured for payment. Maintenance of the device including sediment removal is incidental to the initial installation of the device.

ITEM	DESCRIPTION	UNIT
905001	SILT FENCE	LF
905002	REINFORCED SILT FENCE	LF
905003	SEDIMENT TRAP	CY
905004	INLET SEDIMENT CONTROL, DRAINAGE INLET	EA
905005	INLET SEDIMENT CONTROL, CURB INLET	EA
905006	INLET SEDIMENT CONTROL, CULVERT INLET	EA

SECTION 906 – DEWATERING PRACTICES

906.01 Description. Trap and filter all water produced by dewatering activities. Pump all water produced by dewatering activities to a suitable discharge area. Trap and retain sediment prior to discharging any water into drainage ways, adjoining properties, and Rights-of-Way below a Project site.

906.02 Material. Provide Materials for dewatering practices as specified below:

A. *Portable Sediment Tank.* Provide Materials for portable sediment tanks as follows:

1. *Wire Mesh.* For wire mesh, use steel or galvanized welded wire reinforcement with openings 1/4 inch by 1/4 inch and wire diameter of 23 gauge.
2. *Pipe.* Use pipes that meet the requirements of Section 1031.
3. *Fasteners.* Use fasteners that conform to the requirements of ASTM F 541, Type 1 or Type 2, and are of sufficient strength to lift the portable sediment tank filled with sediment to a depth of 24 inches.
4. *Metal Plate.* For metal plates, use 1/2 inch steel plates.
5. *Geotextile.* Use geotextiles that meet the requirements of Section 1060.

B. *Dewatering Bag.* Provide Materials for dewatering bags as follows:

1. *Fabric***.** Use a non-woven geotextile fabric conforming to the following properties:

Properties	**Values**	**Test Method**
Weight	8 oz/yd² (min)	ASTM D-3776
Tensile Strength	200 lb (min)	ASTM D-4632
Puncture Resistance	130 lb (min)	ASTM D-4833
Flow Rate	70 gal/min-ft² (min)	ASTM D-4491
Permeability	1.5 sec^{-1} (max)	ASTM D-4491
Bursting Strength	380 psi (min)	ASTM D-3786
UV Resistance	70% (min)	ASTM D-4355
AOS	80 US Sieve	ASTM D-4751

*Seams***.** For seams in the fabric, use double-sewn seams forming a continuous surface except for the inlet opening. Minimum seam strength of 100 pounds per inch, when tested in accordance with ASTM D-5884.

2. *Inlet Opening***.** Use inlet openings capable of accommodating a maximum of a 4 inch diameter hose.
3. *Performance Requirement***.** Construct dewatering bags to filter all effluent so that soil particles retained on a #80 sieve (177 microns) are captured in the bag and removed from the discharge water.

C. *Sump Pit.* Provide Materials for sump pits as follows:

1. *Pipe***.** Use 24 inch and 36 inch diameter corrugated metal pipe conforming to the requirements of Section 1031.
2. *Stone***.** Use Delaware No. 57 conforming to the requirements of Section 1004.

3. *Geotextile.* Use geotextile conforming to the requirements of Section 1060.

4. *Wire Mesh.* For wire mesh, use steel or galvanized welded wire reinforcement with openings 1/4 inch by 1/4 inch and wire diameter of 23 gauge.

D. *Skimmer Dewatering Device*

Use the Materials and construction methods that are specified in the Standard Construction Details for skimmer dewatering devices.

E. *Well Point System*

Provide Materials for well point systems in accordance with the appropriate Sections of the Standard Specifications.

906.03 Construction. Use the following construction methods for dewatering practices:

Use dewatering practices shown in the Contract Documents. If the Contract Documents or the Engineer do not specify a specific dewatering practice, use a dewatering practice from the following list that is appropriate for the specific situation. Use of dewatering practices that are not included in this list must be approved by the Engineer prior to use.

A. *Portable Sediment Tank.* Construct, maintain and remove portable sediment tanks as follows:

1. *Construction of Portable Sediment Tank.* Construct portable sediment tanks as follows:

a. Construct the Portable Sediment Tank According to Standard Construction Detail, Portable Sediment Tank.

b. Locate the tank for ease of clean-out and disposal of the trapped sediment and to minimize the interference with the construction activities and pedestrian traffic.

c. With approval from the Engineer, the portable sediment tank may be installed at a different location than is shown on the Plans, within the LOC.

d. Construct watertight welds.

e. First, line the inside of the perforated pipe with a layer of wire mesh; then with a layer of geotextile.

f. Securely fasten the wire mesh and geotextile to the pipe.

2. *Maintenance of Portable Sediment Tank.* Maintain portable sediment tanks as follows:

a. Remove sediment when it accumulates to a depth of 24 inches in a tank designed according to Standard Construction Detail, Portable Sediment Tank, or when it accumulates to one-third of the portable sediment tank height for an approved alternate design.

b. Remove and replace the filter fabric when the portable sediment tank can no longer allow a rate of 125 gallons per minute, when there is a tear, or when directed by the Engineer.

c. Dispose of all sediment collected in the portable sediment tank in an approved disposal area or as approved by the Engineer.

3. *Removal of Portable Sediment Tank.* Remove portable sediment tanks as follows:

a. Remove the portable sediment tank when no longer needed.

b. Regrade the area to match the contours shown on the Plans or, if none are shown, to match the grades that existed before construction the portable sediment tank.

c. Stabilize all areas affected by the portable sediment tank.

B. *Dewatering Bag.* Construct, maintain and remove dewatering bags as follows:

1. *Construction of Dewatering Bag.* Construct dewatering bags as follows:

a. Place dewatering bag(s) at locations designated on the plans or as approved by the Engineer,

within the LOC.

b. Securely attach the dewatering bag to the discharge hose or pipe and maintain a water tight connection.

c. Do not exceed the manufacturer's recommended pumping rate.

d. Discharge the dewatering effluent without causing any erosion between the dewatering bag and the outlet. The type of erosion control will be approved by the Engineer.

2. *Maintenance of Dewatering Bag***.** Maintain dewatering bags as follows:

a. Furnish and place a new dewatering bag when the dewatering bag cannot readily pass any more water as determined by the Engineer.

b. New dewatering bags will be paid per the unit cost of Item 906002, Dewatering Bag.

3. *Removal of Dewatering Bag.* Remove dewatering bags as follows:

a. Remove and dispose of a dewatering bag when it is replaced or when it is no longer needed.

b. Regrade the area to match the contours shown on the Plans or, if none are shown, to match the grades that existed before construction the dewatering bag.

c. Stabilize all areas affected by the dewatering bag.

C. *Sump Pit.* Construct, maintain and remove sump pit as follows:

1. *Construction of Sump Pit.* Construct sump pit as follows:

a. Excavate the sump pit according to the dimensions on Standard Construction Detail, Sump Pit, and at the location shown on the Plans.

b. Place the layer of stone in the bottom of the sump pit as shown on Standard Construction Detail, Sump Pit.

c. Place the stationary pipe with bottom cap on top of the bottom layer of stone.

d. Place the removable pipe 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 12 inches above the lip of the sump pit.

e. Backfill the sump pit with stone.

f. Slope the stone to meet the height of the pipes.

2. *Maintenance of Sump Pit.* Maintain sump pit as follows:

a. Replace the geotextile and, if applicable, the wire mesh on the removable pipe and bottom cap when clogged with sediment.

3. *Removal of Sump Pit.* Remove sump pit as follows:

a. Remove the sump pit and all Materials incidental to the construction of the sump pit.

b. Regrade the area to match the contours shown on the Plans or, if none are shown, to match the grades that existed before construction the sump pit.

c. Stabilize all areas affected by the sump pit, if needed.

D. *Skimmer Dewatering Device*. Construct, maintain and remove skimmer dewatering devices as follows:

1. *Construction of Skimmer Dewatering Device.* Construct skimmer dewatering devices according to the dimensions on Standard Construction Detail, Skimmer Dewatering Device, and place at the location shown on the Plans.

2. *Maintenance of Skimmer Dewatering Device.* Maintain the skimmer dewatering device in proper operational condition while required on the Project.

3. *Removal of Skimmer Dewatering Device.* Remove the skimmer dewatering device from the project site at the completion of the Project, or when directed by the Engineer.

E. *Well Point System.* Construct, maintain and remove well point systems as follows:

1. *Construction of Well Point System*. Construct well point system as follows:

a. Design a well point system capable of controlling groundwater at the Project site in order to install proposed Structures on a dry and stable sub-base. Select a location for the installation of the well point system that will not interfere with the construction of the proposed Structure until such time it can be removed. If any modifications to the construction phasing are necessary for the inclusion of the well point system into the work area, it must be included in the shop drawings.

b. Comply with and obtain all necessary permits as required by Section 902 - Pumping Operations of the DelDOT Standard Specifications. Obtain all permits prior to beginning excavation. Provide a copy of the permit to the Engineer.

c. Install and test the well point system as per the approved design to demonstrate its effectiveness to the satisfaction of the Engineer prior to continuing with the excavation.

d. If the well point system is inadequate and cannot maintain a lowered groundwater elevation necessary to complete installation of proposed Structures on a dry and stable sub-base, modify the system as may be required to achieve the required results.

2. *Maintenance of Well Point System*. Maintain the well point system to ensure working order and continuous drawdown throughout the dewatering process.

3. *Removal of Well Point System*. Remove the well point system as follows:

a. Remove the well point system after all proposed Structures and backfill affected by groundwater conditions have been installed or as directed by the Engineer.

b. Stabilize all areas affected by the well point system, if needed.

906.04 Method of Measurement. The Engineer will measure the quantity of Work acceptably completed for dewatering practices as follows:

A. Portable Sediment Tanks by each placed and accepted.

B. Dewatering Bag by each placed and accepted.

C. Sump Pit by each placed and accepted.

D. Skimmer Dewatering Device by each constructed, placed and accepted.

E. Well Point System will not be measured.

906.05 Basis of Payment. The quantities of Dewatering Practices are paid at the Contract Unit Prices for each acceptably placed. Price and payment constitutes full compensation for furnishing all Materials, fabricating, excavating and backfilling, installing, maintaining (including sediment removal) and removal when no longer needed, for relocating within Project limits, for restoring the site, seeding, for all labor, tools, Equipment, and incidentals required to complete the Work.

The quantity of well point system will be paid lump sum. Price and payment will constitute full compensation for designing; permitting; installing; operating; maintaining; removing; and for all labor, Equipment, tools, Materials and incidentals required to complete the Work. Any required re-design or modification of the well point system shall be incidental to this Item.

ITEM	DESCRIPTION	UNIT
906001	PORTABLE SEDIMENT TANK	EACH
906002	DEWATERING BAG	EACH

ITEM	DESCRIPTION	UNIT
906003	SUMP PIT	EACH
906004	SKIMMER DEWATERING DEVICE	EACH
906005	WELL POINT SYSTEM	EACH

SECTION 907 – WATER CONTROL PRACTICES

907.01 Description. To prevent existing flow or runoff from entering Disturbed Areas by diverting it to a stabilized outlet or to redirect sediment laden water to a sediment trapping device.

907.02 Materials. Provide Materials for water control practices as specified below:

A. *Stone Check Dam.* Provide Materials for stone check dam as follows:

1. *Riprap.* Use riprap that meets the requirements of R-4, Section 1006 with the exception that geotextile will not be required to be placed under the riprap.
2. *Seed.* Use seed that meet the requirements of Section 908.

B. *Temporary Slope Drain.* Provide Materials for temporary slope drain as follows:

1. *Pipe.* Use flexible corrugated polyethylene pipe conforming to AASHTO M 294, Type C, unless otherwise indicated on the Plans.
2. *Plywood.* Use plywood, 48 inch by 48 inch with a nominal thickness of 1/2 inch.
3. *Lumber.* Use construction grade two-by-four. The two-by-four shall measure 2 inch x 4 inch x 24 inch.
4. *Riprap.* Use riprap, size in accordance with Standard Construction Details that meets the requirements of Section 1006.
5. *Seed.* Use seed that meet the requirements of Section 908.
6. *Geotextile.* Use geotextiles that meet the requirements of Section 1060.

C. *Compost Filter Log.* Provide Materials for compost filter log as follows:

1. *Filter Sock.* Made of a 5 millimeter biodegradable HDPE Material with a minimum of 18 inches in diameter.
2. *Compost Media.* Use a plant derived compost that complies with compost material standards and DNREC Specifications (see table below), including being produced from a certified facility through the U.S. Composting Seal of Testing Assurance (STA) program.

Parameter	**Range**	**Testing Method**
Particle Size	For Amendments: 100% pass through a ½" screen For Compost Logs: 99% pass through a 2" screen; max. 40% pass through a 3/8" screen	TMECC 2.02-B
pH	6.0-8.0	TMECC 4.11
Manufactured Inert Material	<1% dry weight basis	TMECC 3.08-A
Organic Matter	35-95% dry weight basis	TMECC 5.07-A
Soluble Salt Concentration	</= 6.0 mmhos/cm	TMECC 4.10-A
Carbon to Nitrogen Ratio	</= 25:1	
Stability (Carbon Dioxide evolution rate)	</= 2 C / unit VS / day	TMECC 5.08-B
Maturity (seed emergence and seedling vigor)	>90% relative to positive control	TMECC 5.05-A
Trace Metals	"Pass"	
Dry Bulk Density	12.5-25 lb/cu.ft.	
Moisture content	40-50%	

907.03 Construction. Use the following construction methods for water control practices.

A. *Stone Check Dam.* Construct, maintain and remove stone check dams as follows:

1. *Construction of Stone Check Dam.* Construct stone check dams as follows:

   a. Construct the stone check dam in reasonably straight sections of the swale or channel. Place the riprap so that it completely covers the width of the channel. Construct the top of the stone check dam 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.

2. *Maintenance of Stone Check Dam.* Maintain stone check dams as follows:

   a. After each rainfall, inspect the stone check dam for sediment accumulation or washout. Repair whenever washout, construction traffic damage, or silt accumulation among the riprap occurs and whenever the stone check dam ceases to function as intended.

   b. *Sediment Removal.* Remove sediment from behind the check dams when it has accumulated to one-half of the original height of the stone check dam at the spillway.

3. *Removal of Stone Check Dam.* Remove stone check dams as follows:

   a. Remove temporary stone check dams only when directed by the Engineer. Ensure that all riprap is removed when the stone check dam is removed. Any Disturbed Areas will be seeded immediately after the check dams are removed.

B. *Temporary Slope Drain.* Construct, maintain and remove temporary slope drain as follows:

1. *Construction of the Temporary Slope Drain.* Construct temporary slope drain as follows:

   a. 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.

   b. Install the appropriate size pipe according to the following table:

Table 907.03-1

Pipe Diameter	*Maximum Drainage Area*
12"	0.5 ac
18"	1.5 ac
21”	2.5 ac
24"	3.5 ac
30"	5.0 ac

   c. Use construction methods for flexible pipe drains that meet the requirements of Section 601. Ensure slope drains have the flexibility and potential for length change to adjust to the interim elevations. Fasten slope drains to the slope by a method approved by the Engineer. Construct and install a plywood anti-seep collar as shown on Standard Construction Detail, Temporary Slope Drain. Ensure that the temporary slope drain discharges 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, ensure that it discharges at the riser crest or weir elevation.

   d. Use construction methods for riprap aprons that meet the requirements of Section 707. A riprap apron, with geotextile, shall be installed below the pipe outlet. The riprap apron shall be a minimum of 3 square yards.

   e. Adjust the elevations of and reconstruct the slope drains so that the slope drains remain functional as the Embankment elevation rises.

2. *Maintenance of the Temporary Slope Drain.* Maintain temporary slope drain as follows:

    a. Maintain Embankment slopes, edge berms, and interceptor berms in conformance with the requirements of Section 202.

    b. Inspect the drain system for clogging and/or breaks and clean and repair as required to remain functional.

3. *Removal of the Temporary Slope Drain***.** Remove temporary slope drain as follows:

    a. When the Engineer determines that the temporary slope drain is no longer required, remove the temporary slope drain and all Materials incidental to the construction of the temporary slope drain. Any Disturbed Areas will be seeded immediately after the temporary slope drain is removed.

C. *Compost Filter Log.* Assemble the compost filter logs by tying a knot in one end of the filter sock, filling the sock with the composted materials, then knotting the other end once the desired length is achieved. Uniformly fill the filter sock with no gaps in compost or presence of large materials that would impede flow and/or create gaps. Preassembled compost filter logs by a supplier are permitted for use. Submit product technical data for approval prior to use.

1. *Construction and use of Compost Filter Log.* Install so that the compost filter log is angled upslope to prevent runoff from washing around the ends; minimum 1 foot elevation difference. Secure in place with stakes installed, at a maximum of 4 feet on center, through the middle of the compost filter log. Use hardwood stakes with the minimum dimensions of 2 inches by 2 inches and 36 inches long. Set the stakes with a minimum 12 inches below grade.

2. *Maintenance of Compost Filter Log.* Inspect on a weekly basis and after storm events. Remove accumulated sediment when it reaches half the height of the compost filter log. Replace if torn, damaged or flattened throughout the life of the Contract at no additional cost to the Department.

3. *Removal of the Compost Filter Log.* Remove the compost filter log upon completion of construction and stabilization of disturbed areas.

907.04 Method of Measurement. Sediment removal is incidental to the maintenance of the Water Control Practice Item. The Engineer will measure the quantity of Work acceptably completed and as follows:

A. Stone Check Dam: the actual number of tons of riprap placed and accepted.

B. Temporary Slope Drain: the actual number of linear feet, measured from end to end of pipe, installed and accepted.

C. Compost Filter Log: the actual number of linear feet, completed in place and accepted.

907.05 Basis of Payment.

The quantity of Water Control Practices is paid for at the Contract Unit Price for each acceptably placed. Price and payment constitutes full compensation for furnishing all Materials, excavating and backfilling, installing, maintaining (including sediment removal), and removal when no longer needed, for restoring the site, seeding, for all labor, tools, Equipment, 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.

For the stone check dam no payment will be made for any replacement of riprap during the Project construction period.

For Temporary Slope Drains, 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.

ITEM	DESCRIPTION	UNIT
907011	STONE CHECK DAM	TONS
907012	TEMPORARY SLOPE DRAIN, 12”	LF
907013	TEMPORARY SLOPE DRAIN, 18”	LF
907014	TEMPORARY SLOPE DRAIN, 21”	LF
907015	TEMPORARY SLOPE DRAIN, 24”	LF
907016	TEMPORARY SLOPE DRAIN, 30”	LF
907017	COMPOST FILTER LOGS	LF

SECTION 908 – SOIL STABILIZATION PRACTICES

908.01 Description. Provide an acceptable, uniform stand of established perennial turf grasses, including topsoil, topsoiling and mulching, on all areas to be treated as shown on the Plans or where designated by the Engineer.

Temporarily Stockpiled Material. Temporary stockpiled Materials should be handled as follows:

Store stockpiled Material away from streams and wetlands within the LOC.

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. Place erodible earth material in neat piles. Seed side slopes in accordance with the incremental stabilization. Seed remaining unstable surfaces immediately following completion of the stockpiling operation.

No payment will be made for costs associated with the installation of erosion and sediment controls required by other agencies having jurisdiction on stockpiles located outside the areas designated on the Plans or required by the Engineer.

Interim and Final Stabilization. An area of the Work will be considered stabilized for erosion control if it meets the criteria in one of the following two cases:

A. 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.

B. Final Stabilization. Meets the requirement for the removal of the temporary erosion controls placed during interim stabilization, and has complete vegetation growth in accordance with this Section as determined by the Engineer. Complete growth of vegetation includes permanent grass reaching a height of 3 inches and 70 percent uniform density over all seeded areas.

Incremental Stabilization. For incremental stabilization, side slopes and other slopes require placement of temporary seeding as the Work progresses in height increments not to exceed 10 foot of Embankment.

Tracking of Slopes. During grading operations track all areas to prevent gully and sheet erosion. The tracking will 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. Before applying seeding Items on the slopes, track the slopes as described above.

Maximum Soil Exposure Times. All erodible earth material exposed by the Work will be stabilized within the time frames specified below:

Location	Type of Stabilization	Maximum Time to Stabilize
Sediment Controls	Temporary Seeding	Seven (7) Calendar Days from the initial completed construction of the bmp device (ex: ditches, sediment traps, dewatering basins, etc.
Short term inactivity not meeting final grade and not to exceed six (6) months	Temporary Seeding	Fourteen (14) Calendar Days from the ceasing of ground disturbing Work in the location.
Areas meeting final grades	Permanent Seeding	Seven (7) Calendar Days from the ceasing of ground disturbing Work in the location.

Points of Ingress and Egress. Construct, maintain, and remove stabilized pads of aggregate on a filter cloth base at each entrance to and exit from the construction site so that construction vehicles and Equipment do not track sediment off-site. Construct entrances in accordance with the Standard Construction Detail, Stabilized Construction Entrance, at the locations shown on the Plans, and as directed by the Engineer.

908.02 Materials. Provide Materials for soil stabilization as specified below:

A. *Topsoil.* Provide Materials for topsoil as follows:

1. Topsoil friable loam soil of uniform quality and free from heavy clay, frozen clods, lumps exceeding 2 inches in diameter, plants, roots, sticks, and foreign materials harmful to plant growth, such as fragments of bituminous, concrete pavement, and surface treatment.

2. Topsoil reasonably free of noxious perennial weeds or wood vegetation and completely void of Johnsongrass *(Sorghum halapense)*, Canada Thistle *(Cirsium arvense)*, Burcucumber *(Sicyos angulatus)*, Giant Ragweed *(Ambrosia trifida)* and Texas Amaranth *(Amaranthus palmeri)*.

3. Topsoil cannot be delivered until the source of supply has been approved by the Engineer.

B. *Topsoiling.* Provide Materials for topsoiling as follows:

1. Topsoiling Material is the existing soils designated to be stripped, salvaged and temporarily stockpiled for later use.

   Determine and incorporate the type and amount of soil supplements needed to create the proper conditions for acceptance of permanent vegetation.

C. *Seeding.* Provide Materials for seeding as follows:

1. *Water*. Use only water meeting the requirements of Section 1021.

2. *Mulch*. Use only mulch that is biodegradable and free of contaminants. Photodegradable products are not acceptable.

   Mulches, except as shown on Plans, are incidental to Seeding.

3. *Grass and Agricultural Seeds.*

a. *Permanent and Temporary Seeding.* The seeding chart on the following pages shall be used for the following specified seeding:

Table A. *Permanent Grass Seeding - Dry Ground (PGS-DG)*

Table B. *Permanent Grass Seeding - Wet Ground (PGS-WG)*

Table C. *Permanent Grass Seeding - Subdivision (PGS-SUB)*

Table D. *Temporary Grass Seeding - Dry Ground (TGS-DG)*

Table E. *Streambank Mix Seeding*

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Table A. Permanent Grass Seeding – Dry Ground (PGS-DG)

Species	%Weed[1]	% Purity	% Germination	Lbs./A	Seeding Dates
Hard Fescue Mixture *(Festuca longifolia and Festuca trachyphylla)*	0.15	98	85	150	
Creeping Red Fescue *(Festuca rubra L.)*	0.15	98	85	85	
Redtop *(Agrostis alba)*	0.75	95	90	40	
Total Perennial Seed Quantity[2] (lbs/Ac)				275	
Winter Cereal Rye *(Secale cereal)*	0.75	98	85	20	1 Nov – 15 Feb
Annual Ryegrass *(Lolium multiflorum)*	0.15	95	90	10	16 Feb – 30 Apr 1 Aug – 31 Oct
Foxtail Millet *(Setaria italic)*	0.5	95	95	20	1 May – 31 July

Table B. Permanent Grass Seeding – Wet Ground (PGS-WG[3, 6])

Species	%Weed[1]	% Purity	% Germination	Lbs./A	Seeding Dates
Redtop *(Agrostis alba)*	0.75	95	90	40	
Creeping Bentgrass *(Agrostis palustris)*	0.75	98	90	25	
Sheep Fescue[4] *(Festuca ovina)*	0.5	98	85	35	
Rough-Stalked Bluegrass *(Poa trivialis)*	0.5	98	80	25	
Total Perennial Seed Quantity (lbs/Ac)				125	

Table C. Permanent Grass Seeding – Subdivision Mix (PGS-SUB)

Species	%Weed[1]	% Purity	% Germination	Lbs./A	Seeding Dates
Turf-type Tall Fescue Cultivar[5] *(Festuca arundinacea var.)*	0.5	98	90	200	
Perennial Ryegrass *(Lolium perenne)*	0.4	90	90	20	
Kentucky Bluegrass *(Poa pratensis)*	0.4	90	80	30	
Redtop *(Agrostis alba)*	0.75	95	90	40	
Annual Ryegrass *(Lolium multiflorum)*	0.15	95	90	20	
Total Seed Quantity (lbs/Ac)				310	

Table D. Temporary Grass Seeding – Dry Ground (TGS-DG)					
Species	**%Weed[1]**	**% Purity**	**% Germination**	**Lbs./A**	**Seeding Dates**
Winter Cereal Rye *(Secale cereal)*	0.75	98	85	50	1 Nov – 15 Feb
Annual Ryegrass *(Lolium multiflorum)*	0.15	95	90	40	16 Feb – 30 Apr 1 Aug – 31 Oct
Foxtail Millet *(Setaria italic)*	0.5	95	95	40	1 May – 31 July

Table E. Streambank Seed Mix – Seeding[7]					
Species	**%Weed[1]**	**% Purity**	**% Germination**	**Lbs./A**	**Seeding Dates**
Tall Fescue KY 31 *(Festuca arundinacea)*	0.5	98	90	180	
Perennial Ryegrass *(Lolium perenne)*	0.4	90	90	20	
Redtop *(Agrostis alba)*	0.75	95	90	20	
Annual Ryegrass *(Lolium multiflorum)*	0.15	98	90	10	
Total Seed Quantity (lbs/Ac)				230	

[1] Title 3 Delaware Code, Chapter 15, Seeds and its associated regulations identify several species of seed designated as Noxious Weeds by the Delaware Department of Agriculture and therefore may not be part of the allowable percentage of weed seeds in any quantity.

[2]Add the applicable quantity of Seasonal Nurse Crop as listed according to the seeding date.

[3] Permanent Seeding - Wet Ground should be used on saturated or seasonally flooded areas as dictated by the wetland limits on the Plans.

[4] *Festuca ovina* must be an improved variety of Sheep Fescue as approved by the Engineer. Selection should be based on performance within the Mid-Atlantic region as determined by the most current National Turfgrass Evaluation Program Progress Report.

[5] Turf-type Tall Fescue Cultivars - 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 - Dry Ground*. No wood fiber mulch may be added to the hydro seeder. Do not apply mulch, fertilizer, or limestone in this seeding area.

[7] No temporary grass seeding will be substituted for this mix. All other aspects and conditions of Section 908 will apply.

D. *Mulch.* Type of blanket (ECB, TRM Type 1, or TRM Type 2) designated on the Plans can only be used as shown on the Approved Product List.

E. *Stabilized Construction Entrance.* Provide Materials for stabilized construction entrance as follows:

1. *Pipe*. Pipe as specified in the Plans.
2. *Seed*. Use seed that meets the requirements of Section 908.
3. *Stone*. Use Delaware No. 3 that meets the requirements of Section 1004.
4. *Geotextile*. Use geotextile that meet the requirements of Section 1060.

908.03 Construction. Use the following construction methods for soil stabilization:

A. *Topsoil.* Construct and maintain topsoil placement as follows.

1. *Construction methods for Topsoil*. Construct topsoil placement as follows:

a. Clear all areas from which topsoil is to be secured of all brush, sticks, weeds, stones, bricks, ashes, and other refuse which may hinder or prevent growth of future plant materials placed in the topsoil.

b. When securing topsoil from an approved source, strata or seams of material not meeting the requirements of topsoil will be removed from the source by the Contractor. If these materials cannot be removed without contaminating the topsoil brought to the jobsite, the source will be abandoned.

c. Placement of frozen topsoil or topsoil on frozen grade is not permitted. Remove clods and lumps exceeding 2 inches in diameter.

d. Thoroughly loosen topsoil to a depth of 3 inches within 72 hours before seeding.

e. Spread topsoil on these areas to a depth sufficiently greater than that specified on the Plans, so that after natural settlement has taken place the Work will conform to the elevations on the Plans.

2. *Maintenance.* Maintain the topsoil until Final Completion and Acceptance of the Contract. Maintenance consists of preserving, protecting, replacing, and such other Work as may be necessary to keep the topsoil in a satisfactory condition.

B. *Topsoiling.* Construct and maintain topsoiling as follows.

1. Place topsoil in accordance with Section 908.03.A.1.d & e.

2. *Maintenance.* Maintain topsoil in accordance with Section 908.03.A.2.

C. *Seeding*. Construct and maintain seeding placement as follows.

1. *Construction methods for Seeding*. Construct seeding placement as follows:

a. This Work consists of preparing the soil and tracking, placing the seed and applying any soil supplements necessary to provide a suitable stand of turf grass and placing mulch. Seed tags may either be removed from the seed bags or digital photo taken with stamp date, prior to seeding, with verification from the Inspector of its use during that Day's operations. Seed mixes will conform to Section 908.02.C.3 (a) Materials Seeding section for Grass and Agricultural Seeds or as indicated on the Plans. Mulch will be placed with no bare ground visible and/or erosion occurrence. Mulch is incidental to seeding.

b. Treat all disturbed soil areas as follows:

i. **Areas meeting final grade.** Complete permanent seeding.

ii. **Areas not meeting final grade.** Complete temporary seeding according to the appropriate seeding date in Table D, unless soil conditions (i.e., frozen ground) dictate the use of other approved temporary soil stabilization practices. Temporary soil stabilization practices shall not exceed 28 Calendar Days.

2. *Maintenance.* Maintain all seeded areas free from weeds and debris in accordance with Section 105.13.

D. *Mulch.* Construct and maintain mulch placement as follows.

1. *Construction methods for Mulch*. Construct mulch placement as follows:

a. Place immediately after seeding operations have been completed.

b. Install and anchor the ECB and TRM Type 1 and 2, in accordance with the Contract Documents.

If the installation requirements of the manufacturer are more stringent than the above, the manufacturer's requirements will govern.

2. *Maintenance.* Maintain mulch placement to ensure no erosion of and no visible observation of the soil surface.

E. *Stabilized Construction Entrance.* Construct, maintain and removal of stabilized construction entrance as follows.

1. *Construction of Stabilized Construction Entrance*. Construct Stabilized Construction Entrance placement as follows:

a. Obtain the approval of the Engineer before any additions, deletions, or changes in the location of a stabilized construction entrance.

b. When required, place entrance pipe in Class C bedding, per Standard Construction Details, and grade to drain. Install the pipe before placing the geotextile or stone. Excavate to the required dimensions as shown in the Standard Construction Details and the compact the subgrade of the stabilized construction entrance. Place the geotextile on the compacted subgrade and place the stone on top to the required depth.

c. Stabilize as described above the entire width at points where ingress and egress occur. The Engineer may direct the Contractor to widen the entrance as required to prevent the entrance location from becoming a source of sediment.

d. If the Contractor chooses to clean construction vehicle wheels to remove sediment prior to leaving the project boundaries, the cleaning will be done in aggregate stabilized areas that drain into approved sediment trapping devices.

2. *Maintenance of Stabilized Construction Entrance.* Maintain Stabilized Construction Entrance placement as follows:

a. Leave all paved surfaces adjoining the Project limits free of accumulated sediment at the end of each Day. The Contractor may utilize any means and methods available to remove sediment provided the cleaning operation itself does not violate the water or air pollution laws of the State.

b. After heavy use and after each rain, inspect the stabilized construction entrance to ensure proper functioning. When the voids in the stone pad are filled, 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, replace the top 2 inches of the stone with 2 inches of clean Delaware No. 3 stone.

3. *Removal of Stabilized Construction Entrance*. When the stabilized construction entrance is no longer needed for access to the Project or when directed by the Engineer, remove all Materials incidental to the construction of the stabilized construction entrance. Restore to the original Plan contours, all areas affected by the stabilized construction entrance. Stabilize the restored areas.

908.04 Method of Measurement. The Engineer will measure the quantity of Work acceptably completed for soil stabilization as follows:

A. Topsoil by the number of square yards or tons acceptably placed.

B. Topsoiling by the number of square yards or tons acceptably placed in the areas shown on the Plans or where directed by the Engineer. Measurements will be made along the surfaces of the completed topsoiling areas.

C. Seeding by the square yards of surface area of acceptably placed permanent or temporary grass seed. Unless otherwise specified on the Plans, mulching will not be measured.

D. Mulch by the actual number of linear feet or square yards of erosion control blanket or turf reinforcement matting acceptably placed.

E. Stabilized construction entrance by the actual number of tons of stone acceptably placed. Stone used for topdressing will be measured as the actual number of tons of stone acceptably placed. Drainage pipe, if used, will be measured as the actual number of linear feet of pipe acceptably placed.

908.05 Basis of Payment.

A. ***Topsoil.*** The quantity of topsoil will be paid for at the Contract Unit Price per Square Yard or Ton. Price and payment constitutes full compensation for preparing the grade; for furnishing, hauling, and placing all Materials including necessary soil supplements such as; lime, sulfur or fertilizer; for maintaining topsoil; for loosening of the topsoil and for all labor, Equipment, tools, and incidentals required to complete the Work.

B. ***Topsoiling.*** The quantity of topsoil will be paid for at the Contract Unit Price per Square Yard or Ton. Price and payment constitutes full compensation for preparing the grade; for hauling, and placing all topsoil salvaged under Section 202; for maintaining topsoil; for loosening of the topsoil, for additional soil supplements, and for all labor, Equipment, tools, and incidentals required to complete the Work.

C. ***Tracking of Slopes.*** All costs associated with tracking of slopes at regular increments are incidental to Section 202. All costs associated with tracking of slopes to prepare a seedbed are incidental to the topsoil Item being applied to the slope surface.

D. ***Seeding.*** The quantity and type of seeding will be paid for at the Contract Unit Price per Square Yard. Price constitutes full compensation for preparing the ground; for furnishing and placing all Materials including seed and mulch; and for all labor, Equipment, tools, Maintenance Bond and incidentals required to complete the Work.

Acceptance of Permanent and Temporary Grass Seeding. Repair all areas failing to meet the specified perennial grass cover at no additional expense to the Department.

Payment Schedule			
Seed Type	Permanent Seed	Permanent Seed	Temporary Seed
Completed Work	at the time seed is acceptably placed	production of a uniform stand of established perennial grass species having attained a height of 3 inches with a density of 70% of the seeded area for acceptance by the Engineer.	at the time seed is acceptably placed
Percent of Total Item Price	80%	20%	100%

E. ***Mulch***. The quantity of erosion control blanket mulch or turf reinforcement matting will be paid for at the Contract Unit Price per Linear Foot or Square Yards. Price and payment constitutes full compensation for furnishing and placing all Materials, including staples, assembly, installation, and maintenance until accepted by the Department.

F. ***Stabilized Construction Entrance***. The quantity of stabilized construction entrances, including topdressing, will be paid for at the Contract Unit Price per 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 of stone. Price and payment constitutes full compensation for the 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 for all labor, Equipment, tools, and incidentals required to complete the Work.

The quantity of drainage pipe is paid for separately.

908.05.1 Maintenance Bond. Furnish to the Department a Maintenance Bond for the appropriate seeding Items, upon Substantial Completion of the Work. The Maintenance Bond shall meet the following requirements:

A. A sum equal to 100 percent of the value of all Permanent Grass Seeding Items paid to the Contractor;

B. All signatures are original signatures, in ink, and not mechanical reproductions or facsimiles of any kind;

C. The Contractor is the named principle;

D. The term of the Bond is for one full year;

E. Section 908 – Seeding Work Items associated with permanent seeding requires completion after Substantial Completion of the Project. The term of the Maintenance Bond will be for a period of one year beyond the completion of permanent seeding Work; and

F. Written by a Surety or insurance company that is in good standing and currently licensed to write surety bonds in the State of Delaware by the Delaware Department of Insurance.

ITEM	DESCRIPTION	UNIT
908001	TOPSOIL	TON
908002	TOPSOIL	SY
908003	TOPSOIL, 4” DEPTH	SY
908004	TOPSOIL, 6” DEPTH	SY
908005	TOPSOIL, 12” DEPTH	SY
908006	TOPSOILING	TON
908007	TOPSOILING	SY
908008	TOPSOILING, 2” DEPTH	SY
908009	TOPSOILING, 4” DEPTH	SY
908010	TOPSOILING, 6” DEPTH	SY
908011	TOPSOILING, 8” DEPTH	SY
908012	TOPSOILING, 12” DEPTH	SY
908013	TOPSOILING, 18” DEPTH	SY
908014	PERMANENT GRASS SEEDING, DRY GROUND	SY
908015	PERMANENT GRASS SEEDING, WET GROUND	SY
908016	PERMANENT GRASS SEEDING, SUBDIVISION	SY
908017	TEMPORARY GRASS SEEDING	SY
908019	STREAMBANK SEED MIX, SEEDING	SY
908020	EROSION CONTROL BLANKET MULCH	SY
908021	TURF REINFORCEMENT MATTING, TYPE 1	SY
908022	TURF REINFORCEMENT MATTING, TYPE 2	SY
908023	STABILIZED CONSTRUCTION ENTRANCE	TON
908501	NATIVE GRASS SEEDING, NO MOW MIX	SY
908502	WET GROUND EROSION CONTROL GRASS SEEDING, FLATS	EA

ITEM	DESCRIPTION	UNIT
908503	WETLAND MITIGATION GRASS SEEDING	SY
908504	COIR FIBER MATTING	SY

SECTION 909 - WATERWAY CONSTRUCTION PRACTICES

909.01 Description. Construct, maintain, and remove temporary waterway diversions in order to allow Work in existing waterway channels by redirecting the water flow of the existing channel around or through the intended work area.

909.02 Material. Provide Material for waterway construction practices as specified below:

A. *Sandbag Dike/Diversion.* Provide Materials for sandbag dike/diversion as follows:

1. *Sand*. Use sand that meets the requirements of Section 1001.
2. *Sheeting*. For sheeting, use polyethylene or other approved Material by the Department's Materials & Research Section, 6mil thick, impervious, and resistant to puncture and tearing.
3. *Pipe*. Use flexible pipe with water tight bands and of size and Material indicated on the Plans.
4. *Pre-fabricated Sandbag*. Use pre-fabricated sandbags manufactured of jute, woven polyester, or polypropylene mesh resistant to ultra-violet radiation of sufficient strength to contain the sand without failure or leakage. The minimum sack size is approximately 16 inch by 25 inch measured inside the seam when the sack is when empty. Fill each sack approximately half full with sand.

B. *Geotextile Lined Channel Diversion.* Provide Materials for geotextile lined channel diversion as follows:

1. *Stone.* Use Delaware No. 3 stone conforming to the requirements of Section 1004.
2. *Geotextile*. Use geotextile that meets the requirements of Section 1060.
3. *Fasteners.* Use steel pins, 3/16 inch in diameter, and at least 18 inch long.
4. *Washers*. For washers, use steel and 1-1/2 inch in diameter.

C. *Turbidity Curtain.* Provide Materials for turbidity curtain as follows:

1. *Curtain.* Furnish turbidity barriers made of a synthetic Material coated with suitable elastomeric or polymeric compound having a high resistance to weathering, ultra violet light, hydrocarbons, fresh and salt water, and temperature extremes. Furnish Material with a tensile strength greater than 200 pounds when measured lengthwise or crosswise. Seams, if required, can be vulcanized welded or sewn. Seams must develop the full strength of the Material.
2. *Flotation Units.* Furnish flotation units that are flexible, sufficiently buoyant to support the required width of the turbidity barrier maintaining a freeboard of at least 3 inches above the water surface level, and contained in a flotation sleeve or collar attached to the turbidity curtain.
3. *Load Lines.* Fabricate load lines into the top and bottom of the turbidity curtain. The top load line consisting of woven webbing or vinyl sheathed steel cable and having a minimum breaking strength of 10,000 pounds. The bottom load line consisting of a minimum 5/16 inch galvanized steel chain incorporated into the bottom hem of the turbidity curtain to act as ballast. The load lines must have suitable devices which develop the full breaking strength for connecting to load lines in adjacent sections.
4. *Shoreline Stakes*. Furnish shoreline stakes of sufficient size to anchor the turbidity curtain in place.
5. *Fasteners.* Furnish fasteners, either 5/8 inch long brass or copper staples, or 17 gage galvanized or aluminized steel tie wires long enough to securely attach the fabric to the posts.
6. *Anchors.* Standard marine type boat anchors with the size, weight, and overall number of the anchors sufficient to hold the turbidity curtain in its intended location. Danforth type anchors for sandy bottoms, or kedge or mushroom type anchors for mud bottoms. Alternate anchoring methods such as heavy concrete weights or driven pilings may be used if approved by the Engineer before use.
7. *Rope.* Use polypropylene rope, 5/8 inch diameter, with at least a breaking strength of 800 pounds.

D. *Stream Diversion.* Provide Materials for stream diversion as follows:

Conform Material to the requirements in the appropriate Sections of the Standard Specifications for components used in the stream diversion system such as sand bags, geotextiles, steel sheet piles, stone, etc.

E. *Stilling Well.* Provide Materials for stilling well as follows:

1. *Riprap*. Use R-4 riprap conforming to the requirements of Section 1006.
2. *Seed*. Use seed that meets the requirements of Section 908.
3. *Geotextile*. Use geotextile that meets the requirements of Section 1060.

909.03 Construction. Use the following construction methods for waterway construction.

Have all required Materials on site before starting construction of the waterway diversion.

A. *General Excavation.* Use the general excavation methods below when performing any waterway construction practice.

1. When excavation is required by the Plans, perform excavation as a continuous and uninterrupted operation.
2. When all excavated Material is to be stockpiled, place and temporarily stabilize all excavated Materials outside the 100 year floodplain at an approved location.

B. *Sandbag Dike/Diversion.* Construct, maintain and remove sandbag dike/diversion as follows:

1. *Construction of Sandbag Dike/Diversion.* Construct sandbag dike/diversion as follows:
   a. Construct the sandbag dike or diversion in accordance as shown in the Standard Construction Detail for Sandbag Dike or Sandbag Diversion. Begin at the upstream end of the proposed channel and proceed to the downstream end. Use sandbags to contain the stream.
   b. When overlapping the sheeting, cover the downstream portion with the upstream portion, and overlap at least 24 inches.
   c. Construct a weir in the sandbag dike as specified on the Project Plans.
2. *Maintenance of Sandbag Dike/Diversion.* Maintain sandbag dike/diversion as follows:
   a. Inspect daily and repair as necessary to maintain an acceptable Work environment.
   b. Immediately repair dike/diversion any damage.
3. *Removal of Sandbag Dike/Diversion.* Remove sandbag dike/diversion as follows:
   a. Remove the dike/diversion upon completion of all Work with the approval of the Engineer.
   b. Regrade the area to match the contours shown on the Plans or, if none are shown, to match the grades that existed before construction the sandbag dike/diversion.
   c. Stabilize all areas affected by the sandbag dike/diversion.

C. *Geotextile Lined Channel Diversion.* Construct, maintain and remove geotextile lined channel diversion as follows:

1. *Construction of Geotextile Lined Channel Diversion.* Construct the geotextile lined channel diversion as follows:
   a. The cross-section of the diversion channel will replicate in size and shape the cross-section of the natural channel, unless otherwise specified. 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, will be constructed under dry conditions. Use sandbags to contain the stream. Install the geotextile as shown on the Standard Construction Detail, Geotextile Lined Channel Diversion.

2. *Maintenance of Geotextile Lined Channel Diversion.* Maintain the geotextile lined channel diversion as follows:

   a. Inspect at the beginning and end of each Day to ensure proper function.

   b. Make repairs immediately.

3. *Removal of Geotextile Lined Channel Diversion.* Remove the geotextile lined channel diversion as follows:

   a. Redirect stream flow to its natural path and remove the Geotextile Lined Channel.

   b. Entirely remove all Materials incidental to the construction of the geotextile lined channel and backfill the area according to Section 207.03.D.

   c. Regrade the area to match the contours shown on the Plans or, if none are shown, to match the grades that existed before constructing the channel diversion.

   d. Stabilize all areas affected by the construction of the geotextile lined channel diversion.

D. *Turbidity Curtain, Floating.* Construct, maintain and remove turbidity curtain, floating as follows:

1. *Construction of Turbidity Curtain, Floating.* Construct turbidity curtain, floating as follows:

   a. Submit the manufacturer's drawings and technical specifications to the Engineer for approval before the installation of the turbidity curtain and its accessories.

   b. Follow all the directions of the turbidity curtain manufacturer, when assembling and installing a turbidity curtain.

   c. Install the turbidity curtain parallel to the flow of water only, i.e. along the river bank. Do not install the turbidity curtain perpendicular to the direction of stream flow, i.e. from river bank to opposing river bank. Contain all construction activities generating any sediment or turbidity into the waterway within the turbidity curtain.

   d. Begin installation at high tide from a shoreline anchorage and work along with the current in a downstream direction.

   e. Form a continuous vertical and horizontal barrier to suspended sediment. Rest the bottom of the turbidity curtain in contact with the bottom of the waterway for the entire length of the turbidity curtain.

   f. Float the turbidity curtain into position, attached to the anchor lines, and then unfurl. Securely attach curtain panel ends together using rope lashings. Securely tie the top lashing to the anchor line. 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, supply and place additional anchorage.

   g. Securely fasten the curtain to the side of the stakes facing the Work area generating the sediment and turbidity to ensure a sediment-tight seam.

2. *Maintenance of Turbidity Curtain, Floating.* Maintain turbidity curtain, floating as follows:

   a. Maintain the turbidity curtain so that no sediment caused by the Project enters the waterway beyond the turbidity curtain, throughout the Project construction period.

   b. Repair or replace all turbidity curtain damaged before installation, during installation, or during the life of the Contract to the satisfaction of the Engineer.

3. *Removal of Turbidity Curtain, Floating.* Remove turbidity curtain, floating as follows:

   a. Do not remove the turbidity curtain until completion of affected Work and the turbidity has settled to no more than what existed before the start of construction. Furl in place, then release the turbidity curtain from its anchors and towed out of the water when directed by the Engineer. Minimize

turbidity to adjacent waters during the removal of the turbidity curtain and all related components. The turbidity curtain and related components are the property of the Contractor.

E. *Stream Diversion.* Construct, maintain and remove the stream diversion as follows:

1. *Construction of Stream Diversion.* Construct the stream diversion as follows:

   Dewatering of the Work area shall be in accordance with Section 902 of the Standard Specifications.

   The design shown in the Plans is based on the most conservative stream diversion approach anticipated at the time of Bid, i.e., the largest footprint needed to complete the Work. Make every effort to implement the design within the limits shown on the Plans without additional impacts to the stream or wetland depicted on the Environmental Compliance sheet(s).

   If additional stream and/or wetland impacts are necessary, submit a preliminary layout of the impacts to the Engineer. Obtain written permission before proceeding with final design. Assume all cost of design and construction of alternate plans.

   The design of the alternate plans must comply with all applicable hydrologic and hydraulic engineering standards in effect when preparing the proposed alternative stream diversion plan regarding capacity of the system and potential surface water impacts upstream and downstream of the stream diversion.

   If permission is granted to proceed with final design of a proposal for an alternate stream diversion, prepare and submit the alternate in accordance with Section 105.04 of the Standard Specifications. Prepare alternate plans and submit three (3) copies of the final design as follows for review:

   a. Plans require sufficient detail to demonstrate the adequacy of the Materials, methods, and Equipment in providing stream diversion and erosion and sediment control;

   b. Include an itemized list of all Materials and Equipment to be used;

   c. Scaled drawings of the proposal overlaid on the Environmental Compliance sheet(s) in the Plans;

   d. supporting computations, maps, tables, etc.;

   e. all necessary supporting paperwork required for the submission of the permit modification request to the appropriate permitting agency;

   f. A table of any increased temporary impacts to wetlands and open waters.

   The alternate plans must be signed and sealed by a Professional Engineer licensed in the State of Delaware.

   The Department's Environmental Studies Office will make application for permit modifications through the appropriate permitting authorities. The Environmental Studies Office will advise the Engineer of any missing or additional information needed to process the permit modification.

   The Department cannot guarantee the approval of any proposed alternative plan by any permitting authority or the Department. Denial of the alternate plan, long review times, or multiple submissions to any or all permitting authorities to gain approval does not relieve the Contractor from its obligation to complete the Project on time. The time between submission of the final status of the permit modification(s) and response from the Engineer may take as long as two months. No additional time will be granted for delays resulting from failing to schedule sufficient time for permit modification review and final decision.

   Installation and testing of the approved stream diversion system is required to demonstrate its effectiveness to the satisfaction of the Engineer before disturbance of the existing Structure. Correct any deficiencies found by the Engineer at no additional cost to the Department.

2. *Maintenance of Stream Diversion.* Maintain the stream diversion as follows:

   a. Maintain each component in accordance with the Contract Documents.

3. *Removal of Stream Diversion.* Remove the stream diversion as follows:

   a. Remove each component in accordance with the Contract Documents.

F. *Stilling Well.* Construct, maintain and remove the stilling well as follows:

1. *Construction of Stilling Well.* Construct the stilling well as follows:

   a. Excavate to the dimensions shown on the Plans or a minimum of 5 foot x 5 foot. Temporarily stockpile all channel bed Material from the excavated area. When overlapping the sheeting, the upstream portion will cover the downstream portion, and the overlap will be at least 24 inches.

   b. Line all surfaces of the stilling well with the geotextile prior to placing the riprap. Place the geotextile and riprap as indicated on the Plans, Standard Construction Detail, Stilling Well, and Section 707.

2. *Maintenance of Stilling Well.* Maintain the stilling well as follows:

   a. Maintain the stilling well to the original dimensions and function of the stilling well throughout the Project construction period. Remove and dispose of all trash and debris that enters the stilling well and interferes with the functioning of the stilling well.

3. *Removal of Stilling Well.* Remove the stilling well as follows:

   a. Remove the stilling well upon completion of all Work with the approval of the Engineer.

   b. Regrade the area to match the contours shown on the Plans or, if none are shown, to match the grades that existed before constructing the stilling well.

   c. Stabilize all areas affected by the construction of the stilling well.

909.04 Method of Measurement. Sediment removal is incidental to the maintenance of the Waterway Construction Practice Items. The Engineer will measure the quantity of Work acceptably completed for waterway construction as follows:

A. Sandbag Dike/Diversion by actual number of cubic feet of sandbags placed and accepted. All measurements will be based on one sandbag being 1 cubic foot.

B. Geotextile Lined Channel Diversion by the actual number of cubic yards excavated and accepted.

C. Turbidity Curtain, Floating by actual number of linear feet of turbidity curtain placed and accepted. Measurements are from edge to edge of the turbidity curtain along the support cable.

D. Stream Diversion will not be measured.

E. Stilling Well by the actual number of cubic yards excavated and accepted.

909.05 Basis of Payment.

A. Sandbag Dike/Diversion. The quantity of sandbag dikes and sandbag diversions will be paid for at the Contract Unit Price per cubic feet. Price and payment constitutes 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 for all labor, tools, Equipment, and incidentals required to complete the Work.

   The quantity of pipe will be incidental.

B. Geotextile Lined Channel Diversion. The quantity of geotextile lined channel diversion will be paid for at the Contract Unit Price per cubic yard. Price and payment constitutes full compensation for excavating; for furnishing and placing all Material, including geotextile, stone, washers, pins, seed; 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 for all labor, Equipment, tools and incidentals required to complete the Work.

C. Turbidity Curtain, Floating. The quantity of floating turbidity curtain will be paid for at the Contract Unit Price per linear foot. Price and payment constitutes 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.

D. Stream Diversion. The quantity of stream diversion will be paid for at the Contract lump sum price. Price and payment constitutes full compensation for all materials and labor, including, but not limited to, all sand bags, steel sheeting, diversion pipes, pumps, sediment retaining devices, riprap, geotextiles, stilling wells, sump pits and/or any excavation necessary; as well as installation and maintenance of all Items during operation, and for removal of all Items after they have served their purpose and restoration of the stream to preconstruction lines and grades except as provided for by the Plans. Cost associated with repairing, replacing and maintaining the stream diversion Items shall be included in the lump sum Bid Price.

The stream diversion system is designed to overtop in high flow events. Any damage during an overtopping event, including necessary cleaning and rebuilding of the stream diversion system shall be paid under force account. Payment will not be made for any stream diversion Materials installed prior to approval from the Engineer.

All Materials used for the stream diversion system are the property of the Contractor after removal except channel bed fill to be utilized in the final Work. Payment includes design and preparation of all plan submittals and supporting paperwork and copies, permit acquisition costs, and all labor, Equipment, tools, and incidentals necessary to complete the stream diversion operation.

Payment for dewatering of the Work area shall be in accordance with Section 902 of the Standard Specifications.

E. Stilling Well. The quantity of stilling well will be paid for at the Contract Unit Price per cubic yard. Price and payment constitutes 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 for all labor, Equipment, tools, and incidentals required to complete the Work.

The quantity of riprap will be paid for according to Section 707.

ITEM	DESCRIPTION	UNIT
909001	SANDBAG DIKE	CF
909002	SANDBAG DIVERSION	CF
909003	GEOTEXTILE LINED CHANNEL DIVERSION	CY
909004	TURBIDITY CURTAIN, FLOATING	LF
909005	STREAM DIVERSION	LS
909006	STILLING WELL	CY

SECTION 910 – STORMWATER MANAGEMENT FACILITIES

910.01 Description. This work consists of constructing stormwater management facilities.

910.02 Materials. Provide Material as specified below and in accordance with what is shown in the Plans:

A. *Infiltration Stone (No. 3, No. 8, or No. 57).* Place infiltration stone meeting the following requirements:

1. *Stone*. Use stone that meets the material and gradation requirements of respective Section 1004 of the DelDOT Standard Specifications. Use infiltration stone that is washed, free of stone dust, fines or soil particles and has a maximum of 2.0 percent passing the #200 sieve when tested according to AASHTO T11. Do not use crushed concrete or recycled asphalt pavement (RAP) for this purpose.

2. Use geotextile fabric meeting the requirements in Section 1060 of DelDOT's Standard Specifications.

B. *Clay Borrow.* Use clay borrow that conforms to the following requirements:

1. *Clay Borrow, Cut-Off Trench*. Use clay borrow to construct cut-off trenches that conforms to the Unified Soil Classification System designation SC, CL or CH and is free of rubbish; organic matter such as leaves, roots, grass, or sewage; and stones larger than 6 inches and other objectionable material.

2. *Clay Borrow, Pond Liner*. Use clay borrow for pond liners that conforms to the Unified Soil Classification System designation GC, SC, CL, or CH and is free of rubbish; organic matter such as leaves, roots, grass, or sewage; and stones larger than 6 inches and other objectionable material.

3. *Borrow Sources*. Prior to removing Material from a borrow source, comply with the requirements of Section 209.03.1.

4. *Borrow Source Testing*. The Department will assist the Contractor in verifying a borrow source as detailed in Section 209.03.2

C. *Outlet Structure, Concrete.* Construct concrete outlet Structures that meet the following requirements:

1. *Borrow*. Use clay borrow for backfill Material that conforms to the requirements of Section 1002.

2. *Concrete*. Concrete used in riser Structures may be precast or cast in place. Use only cast-in-place concrete for walls, anti-seep collars, and bedding for a principle spillway. Use Class A concrete for foundations, riser structures, walls, anti-seep collars, and bedding for a principle spillway pipe. Use Class A concrete meeting the requirements of Section 1022.

3. *Reinforcing Steel*. Use Grade 60 reinforcing steel meeting the requirements of Section 1037.

4. *Grout*. Use non-shrink grout conforming to the requirements ASTM C 1107.

5. *Pipe*. Refer to Section 1031 of these Standard Specifications for the reinforced concrete pipe when used as a principal spillway.

6. *Gaskets*. Refer to Section 1031 of these Standard Specifications for the gaskets to be used with reinforced concrete pipe.

7. *Steps*. When steps are required, use molded plastic steps with a reinforcing bar core conforming to the requirements of AASHTO M31 / M31M, ASTM C478, and ASTM D4101.

8. *Trash Rack.* All trash racks supplied for outlet Structures will be aluminum.

D. *Stormwater Management Pond.* Provide Material for the construction of stormwater management ponds that meets the requirements of Section 910.02B.

E. *Infiltration Trench.* Construct infiltration trenches that meet the following requirements:

1. *Stones***.** Stones will meet the requirements of Section 910.02A.

2. *Geotextile***.** Geotextile will meet the requirements of Section 1060.

3. *Polyvinyl Chloride (PVC) Pipe***.** Use schedule 40 PVC pipe meeting the requirements of Section 1031.

4. *Reinforcing Bar***.** Use epoxy-coated, No. 4 reinforcing bar that conforms to the requirements of AASHTO M31, Grade 60 and ASTM A775.

910.03 Construction.

A. *Infiltration Stone (No. 3, No. 8, or No. 57)* Use the following construction methods for infiltration stone.

1. *Subgrade Establishment.*

a. Establish the soil subgrade to the design subgrade elevation. Excavate the area in a manner that the subgrade elevation will be left in as near an undisturbed condition as possible. Use only low ground pressure Equipment to traffic the soil within the infiltration area.

b. Where erosion of the native material subgrade has caused accumulation of fine materials and/or surface ponding, remove this material with light Equipment and scarify the underlying soils to a minimum depth of 6 inches with a York rake or equivalent and light tractor.

c. Bring the subgrade to the lines, grades, and elevations indicated on the Plans. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction before placing the aggregate subbase.

d. After excavation is complete, line the bottom and sides of the stone reservoir with geotextile to prevent upward piping of the underlining or underlying soil. Place the fabric as smoothly as possible with a 12 inch minimum overlap or greater as recommended by the manufacturer.

2. *Aggregate Placement*.

a. Prior to the placement of aggregate, remove any excess soils or contaminated soils from the surface of the subgrade.

b. Place Materials in layers not exceeding 6 inched bulk and 4 inches compacted in depth, unless noted otherwise on the Plans.

3. *Aggregate Compaction*.

Use a static tandem drum type roller of not less than five tons weight to compact aggregate. Roll until no visible movement or significant settlement of the stone occurs beneath the roller drum. Plate compactors may be used for smaller areas where the larger Equipment cannot reach.

4. *Aggregate Tolerances.*

a. When placing base course aggregate in areas to be paved with pervious pavement (asphalt or concrete), construct the surface of the aggregate to compacted grade within the range of - 0.50 inch and + 0.00 inch. Use string lines or electronic grade controls to establish the finished grade of each lift of stone.

b. Upon completion of fine grading, compaction, and Contractor confirmation of conformance with the tolerances, notify the Engineer and schedule an inspection for approval. Do not pave or place concrete over the infiltration stone until it has been inspected and approved by the Engineer.

B. *Clay Borrow.* Use the following construction methods for clay borrow.

Place and compact clay borrow in accordance with the requirements of Section 910.03.D.4 and as directed by the Engineer.

C. *Outlet Structure, Concrete.* Use the following construction methods for Outlet Structure, Concrete.

1. *Excavation*. Excavate for the outlet Structure to the required depth. Compact the foundation upon which the Structure is to be placed to a firm and level, and unyielding surface.

2. *Riser*. To construct concrete risers pour the concrete in place or use pre-cast concrete elements. If the concrete risers are pre-cast, design the lifting lugs, and all hardware required to transport and install the Structure. Do not use the top slab to lift the riser Structure. Fill any space between pipes and the walls

of the pre-cast riser 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 inches.

3. *Anti-Seep Collars*. To construct anti-seep collars, excavate the subgrade to the dimensions of the bottom half of the collars. Use the excavation as the form for the bottom half of the anti-seep collars. Place formwork for the top half of the anti-seep collars.

4. *Principal Spillway Outfall Pipe*. Use Class A pipe bedding, per Standard Construction Details, for the principal spillway pipe.

    a. Use concrete shims to establish grade and alignment of the pipe. Do not use lumber or bricks for shims. Exercise care during backfill to prevent any pipe movement from the proposed horizontal and vertical alignment.

    b. When the principal spillway outfall pipe is to be placed partially or completely in fill, perform the Work in the following order: first, construct the fill Embankment 24 inches above the proposed top of pipe. Second, excavate the trench to the required grade with side slopes no steeper than 1:1.

    c. Place bell and spigot pipes with the bell ends upstream. Keep the pipe trench free of standing water during pipe placement and backfilling using an approved dewatering method.

5. *Backfill*. Place backfill Material next to pipes and other Structures to the required elevation in 4 inches horizontal loose-thickness lifts at the same rate on all sides to prevent damage to the Structures from unequal loading.

    a. Compact each lift using a manually directed power tamper under and around the pipe and other Structures to 95 percent or more of maximum dry density by AASHTO T-99 Method C, Modified.

    b. Do not place backfill Material next to cast- in-place concrete Structures until the concrete has reached the strength requirements of Section 610.03.K.

    c. Place a minimum depth of 24 inches of hand compacted backfill Material over the pipe before crossing it with construction Equipment.

D. *Stormwater Management Pond.* Use the following construction methods to construct stormwater management ponds.

1. *Excavation*. Excavate for stormwater management ponds to the lines and grades shown on the Plans or as directed by the Engineer.

    a. Use all suitable excavated Material to construct the dam foundation and Embankment. If permitted by the Engineer, Materials determined by the Engineer to be unsuitable for use in the dam foundation and Embankment may be deposited on slopes. Otherwise, use all excess Material meeting the requirements for Embankment to construct Embankments as required by the Contract Documents. Remove and dispose of all Material in excess of the Project's Embankment requirements and all Material that is unsuitable for Embankment. Excess material is to be utilized per Section 202.03.e. Excavate rock per the requirements of Section 202. Rock excavation will be paid under Section 202.

2. *Dam Foundation and Reservoir Preparation*. Prior to constructing the dam foundation and reservoir, clear the area of trees, logs, stumps, roots, brush, boulders, sod, topsoil and rubbish. Grade all surfaces under the foundation to remove irregularities. Scarify the surfaces parallel to the axis of the fill to loosen the soil a minimum of 2 inches in depth. Control the moisture content of the loosened Material as specified in Section 910.03.D.4.

    a. Keep the foundation area free of standing water during placement of the Material for the dam through the use of approved dewatering methods. Clean exposed rock surfaces under the foundation of all loosened earth Material.

    b. Fill test pits and other cavities with compacted soil conforming to Section 209.

c. Stockpile topsoil and use in the completed Embankment and other areas as directed by the Engineer. Stockpile and use topsoil per the requirements of Section 202 and Section 908.

3. *Foundation Cutoff Trench.* Locate the foundation cutoff trench under the dam centerline or as shown on the Plans. Key the foundation cutoff trench into the original ground extending down to a relatively impervious layer and up the abutment slope to at least the ten-year pool elevation. Excavate the foundation cutoff trench prior to placing the dam Embankment. Extend the cutoff trench a minimum of 4 feet below the original ground surface or as indicated on the Plans. The trench shall have a minimum 4 foot 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.

4. *Dam Foundation and Embankment Placement and Compaction*. Do not place fill until the required foundation preparation has been completed and the foundation excavation has been inspected and approved by the Engineer. Do not place fill on frozen surfaces. Do not use frozen Materials to construct the fill.

   a. If the surface of any layer becomes too hard, smooth or dry for proper bond with the next layer, scarify the surface of the layer parallel to the axis of the dam to a depth of not less than 2 inches and bring the Material to the optimum moisture content before the next layer is placed.

   b. Fill Material shall contain the optimum moisture to obtain the required density. If the Material is too wet or dry, remove and replace it. If the Material is too dry, add water and mix the soil until the optimum moisture content is met.

   c. Place fill Material beginning at the lowest area in 8 inches to 12 inches thick continuous, horizontal layers over the entire length of the fill. Obtain compaction using approved rollers or compactors. Begin compaction or rolling at the edges of the fill and progress towards the center of the Embankment. Continue compaction until each layer of the full width of the Embankment is thoroughly and uniformly compacted to at least 95 percent or more of maximum dry density by AASHTO T-99 Method C, Modified.

5. *Maintenance of the Stormwater Management Pond*. When the stormwater management pond is used as a sediment basin, sediment will be removed when the cleanout elevation is reached. Dispose of the sediment at a location approved by the Engineer.

E. *Infiltration Trench.* Use the following construction methods for infiltration trench.

Mark the footprint of proposed infiltration trench and 10 feet outside of the perimeter with construction tape at the beginning of Project construction. Do not allow construction Equipment within the marked area until construction of the infiltration trench begins. Do not construct the infiltration trench until the drainage area is stabilized with a good stand of grass at least 6 inches tall and approved by the Engineer.

During construction, exercise caution not to disturb and compact any in situ soil below the proposed bottom grade and within the 6 foot wide footprint of the infiltration trench. Scarify any glazed and compacted surface caused by the excavation operation before backfilling the trench with stone.

Construct the observation well using 6 inch diameter Schedule 40 PVC with 4 rows of 3/8 inch diameter holes, evenly spaced around the pipe and 6 inch on center vertically. Construct a removable cap on the top and place an 18 inch length of rebar through the pipe and secure on the bottom to serve as an anchoring system. Extend the observation well from the bottom of the trench to 1 foot above the top elevation.

Construct the infiltration trench to the dimensions shown on the construction Plan.

910.04 Measurement. The Engineer will measure the quantity of Work acceptably completed for stormwater management facilities as follows:

A. Infiltration Stone by the number of cubic yards of stone placed and accepted.

B. Clay Borrow by the number of cubic yards measured in accordance with Section 209.04.

C. Outlet Structure, Concrete by each or Lump Sum, constructed and accepted.

D. The quantity of stormwater management ponds will be measured as the actual number of cubic yards of Material excavated to construct stormwater management ponds and remove the sediment, if used as a sediment basin. 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.

E. Infiltration Trench by the linear feet constructed and accepted.

910.05 Payment.

The Engineer will pay the quantity of Work acceptably completed and as follows:

A. For Infiltration Stone, price and payment will constitute full compensation for subgrade preparation, furnishing, hauling, placing, compacting the stone, and for all labor, tools, Equipment, and incidentals necessary to complete the Item.

B. For Clay Borrow, price and payment will constitute full compensation for stripping, excavating, hauling, placing, and compacting the borrow Material and for all labor, Equipment, tools, and incidentals required to complete the Work.

C. For Outlet Structure, Concrete, each, 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, trash rack, 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.

D. For Outlet Structure, Concrete, Lump Sum, 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, trash rack, 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.

A breakout sheet is attached to the Proposal that lists the size of each outlet Structure. Supply a cost for each outlet Structure. The lump sum price for Item 910007 shall be the sum of the cost for all outlet Structures listed.

E. For stormwater management ponds 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 not specified to be removed under this Item will be paid under the respective pay Items otherwise provided in the Contract.

F. For Infiltration Trenches, price and payment will constitute full compensation for furnishing and installing all required Materials, including stones, geotextile, PVC pipes, anchor bars; and for all labor, tools, Equipment, and incidentals required to complete the Work.

ITEM	DESCRIPTION	UNIT
910001	INFILTRATION STONE, NO.3	TON
910002	INFILTRATION STONE, NO.8	TON
910003	INFILTRATION STONE, NO.57	TON
910004	CLAY BORROW, CUT-OFF TRENCH	CY
910005	CLAY BORROW POND LINER	CY
910006	OUTLET STRUCTURE	EACH
910007	OUTLET STRUCTURE	LS
910008	STORMWATER MANAGEMENT POND	CY
910009	INFILTRATION TRENCH	LF

SECTION 911 – PLANTINGS

911.01 Description. This Work consists of furnishing and planting specified plants, shrubs, and trees and the replacement and cultural care of the Material.

911.02 Materials.

911.02.1 Plant Material.

A. *Quality.* Furnish plants 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.

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 Section 911.03.3.

B. *Measurements.* Furnish plants conforming to all sizes and measurements specified in the Plant List provided with the Contract Documents. 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 "American Standard for Nursery Stock" (ANSI Z60.1). 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 trunk diameter of all trees shall be taken 6 inches above the ground level for up to and including 4 inch diameter sizes, and 12inches 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. Pruning of branches for this effect is not permitted 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. If plants smaller than specified are provided, submit a credit 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 Section 911.02.1e.

C. *Inspection.* Provide all certificates of inspection of plant Materials that may be required by Federal, State, or other authorities with the shipment of plants. Furnish complete information as to the location of all plants intended to supply and use. The Department reserves the right 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. Protect the plant Materials 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 "Standardized Plant Names" as accepted by the American Joint Committee on 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.*

G. 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.

911.02.2 Trees. Furnish trees with straight trunks according to their habit of growth and well branched and rooted. Shade trees of standard variety shall have a single leader and shall be branched at 6 to 8 feet height unless otherwise directed.

911.02.3 Shrubs. Furnish shrubs, well branched, with full and compact growth and have ample well branched root systems capable of sustaining vigorous plant growth.

A. *Woody Shrub Cutting.* Cuttings shall be fresh 24 inch 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.

911.02.4 Ground Cover and Herbaceous Perennials.

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 plant Material shall be at least six months old and shall have been growing for at least three months in the size specified unless otherwise detailed in the Contracted Documents, and as verified by the Department's inspection representative.

911.02.5 Soil Mix.

A. *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 percent nor more than 10 percent organic matter. The topsoil shall exhibit the following grading analysis:

Sieve Size	*Minimum Percent Passing*
2”	100 percent
No. 4	90 percent
No. 10	80 percent

Ensure that the topsoil meets the sieve analysis, acidity, and organic matter requirements. Provide a certificate of analysis of soil samples to the Engineer and approved prior to delivery of topsoil to the Project site.

B. *Peat Moss and Peat Humus.*

1. *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. Provide written certification from the manufacturer that the peat moss was obtained from sphagnum peat bogs.

2. *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 2 inch 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 EF (105 EC)*

C. *Composted leaf mulch.* Composted leaf mulch may be used in lieu of peat moss or peat humus and shall be free of wood, metallic substances, glass or other contaminates.

911.02.6 Fertilizer. Fertilizer shall be a 20-10-5 analysis or approved equal in accordance with the following minimum guaranteed analysis:

Total Nitrogen (N) Derived from urea-formaldehyde 7.0% water soluble nitrogen 13.0% water insoluble nitrogen	20.00%
Available Phosphoric Acid (P2O5) Derived from calcium phosphate	10.0%
Soluble Potash (K2O) Derived from potassium phosphate	5.00%
Combined Calcium (Ca) Derived from calcium phosphate	2.60%
Combined Sulfur (S) Derived from ferrous and potassium sulfates	1.60%
Iron (expressed as elemental Fe) Derived from ferrous sulfate	0.35%

The fertilizer shall be formulated in tablet form weighing a minimum of 20g per tablet.

The fertilizer shall conform to all State and Federal regulations. Furnish an affidavit from the vendor or a testing laboratory as to the available nutrients contained therein.

Furnish fertilizer 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.

911.02.7 Mulch. Furnish mulch, shredded hardwood bark or wood chips, 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. Shredded hardwood bark shall be from a deciduous hardwood source and be mechanically ground to a maximum size of 6 inches. In addition, the bark shall be relatively free of bark fines dust and shall exclude all foreign and toxic substances.

B. 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, loose, non-pelletized fertilizer with analysis in accordance with Section 911.02.5.b shall be applied at the rate of 0.5 pounds per square yard prior to wood chip placement.

Only one of the above mulches will be selected and approved for use throughout the entire Project. Submit written certification for the above listed requirements of the mulch.

911.02.8 Stakes, Guys, and Related Materials. Staking and guying shall be as per the Standard Construction Details or alternate method approved by the Engineer.

A. *Tree Stakes.* Hardwood stakes shall be at least 2 inch by 2 inch rough sawed to the length required. Stakes shall be free from knots, rot or other defects that impair strength.

B. *Guying straps.* Guying straps shall be one and one-half to two inches wide, of polymer or nylon construction, with grommets at both ends to accept wire or heavy twine.

C. *Anchoring systems.* Anchors for guy wire shall be malleable iron or aluminum alloy with 3000 pound 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. Follow manufacturer's recommendations for installing ground anchoring systems.

911.02.9 Water. Conform to the requirements of Section 1021.

911.03 Construction.

911.03.1 Planting Periods. Plant during the following planting period with the exceptions as noted:

Balled or Burlapped and Potted or Container Grown Plant Material:

March 1 to May 15; September 1 to November 30:

A. All planting of broadleaf evergreens during the fall season shall be completed by November 1.

B. All Material planted from May 16 to August 31 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.

C. Install Woody Shrub Cuttings as dormant Materials between October 30 and December 1 or between March 1 and April 1.

The above mentioned periods may be extended or reduced according to weather and soil conditions at the time and upon written request from the Contractor to the Engineer for approval. Planting outside the planting window does not relieve the contractor of his guarantee. The Engineer reserves the right to stop planting operations at any time.

Do not plant when weather conditions are unfavorable for proper Work or when the soil is in a frozen condition.

911.03.2 Soil Mixture. Furnish soil mixtures for the various plantings conforming to the following:

A. *All Plants Except Ericaceous Material.* For each cubic yard of baled peat moss, or approved equal, add from 43 to 54 cubic yards; of planting topsoil.

B. *Ericaceous Plants.* For each cubic yard of baled peat moss, or approved equal, add from 36 to 45 cubic yards; of planting topsoil. If peat humus is furnished in lieu of peat moss in the above mix, proportion the mixture with 1.8 cubic yards of peat humus for each cubic yard 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.

Mix the above soil mixtures as specified in an area approved by the Engineer. Provide at least 48 hours advance notice to the Engineer before preparing any soil mixture. 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 911.02.5.a.

Place fertilizer, in accordance with Section 911.02.5.b. according to the following requirements:

1. *Balled and 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.
2. *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.
3. *Trees.* Use one 20 g tablet for each 1/2 inch of tree trunk diameter based on size specified for planting.
4. *Shrubs.* Use one 20 g tablet for each 12 inches of height or spread based on size specified for planting.
5. *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.

911.03.3 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 balled and burlapped 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 or shall be removed from the site immediately. Handle all plants so that roots are adequately protected and moist at all times. Protect all plants by covering with canvas, wet straw, burlap, moss, or other suitable Material and keep covered until ready to be planted. Trees should not be planted with frozen earth balls. Containerized plant Material shall be growing in the specified size container for at least six months and shall not display signs of being root bound or unnatural ratio of planting medium versus root mass.

911.03.4 Location of Plants. Place plants as indicated on the Plans. Locations of the plants may be shifted to avoid utilities subject to the approval of the Engineer. No excavation shall commence until locations are approved.

911.03.5 Planting. Plant all trees and shrubs in pits as detailed in the Construction Documents. Pits shall not 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 inches 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.

Cover all backfill topsoil with a waterproof Material after mixing. Backfill pits with specified soil mix and compact firmly under ball of roots to establish a firm foundation. Set plants 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. With care, firmly tamp the "Soil Mixture" under and around the base of the ball to fill all voids. When partially backfilled and compacted, remove the burlap and any wire baskets from the sides and tops of the balls and cut away to prevent air pockets, leaving the burlap from under the balls. Properly dispose of all burlap, wire baskets and other containers from the jobsite at the end of each Day. Fill the balance of the planting hole with the planting mixture, and form a ring of earth around the plant to produce a dish for watering. Water all plants immediately after planting as directed by the Engineer. For this initial watering, completely saturate all backfill in the pits and beds during the same Day of planting. Use care 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. Repair any damage to all grassed, planted, or other landscaped areas, caused by the Contractor, to the satisfaction of the Engineer.

Prepare ground cover and herbaceous perennial areas by rototilling to a minimum depth of 10 inches. 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 determines the actual depth for individual plant excavation. Backfill plants with the soil mixture and compact firmly around roots. Place a minimum of 2 inches of approved mulch on a smooth and uniform grade.

A. *Pruning.* Prune all plants 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. Perform all pruning using sharp tools by workers skilled in this operation. Make all cuts flush, leaving no stubs. On all cuts over 3/4 inch in diameter and bruises or scars on the bark, trace back and remove the injured cambium to living tissue; smooth and shape all wounds so as to preserve the branch bark ridge.

B. *Watering.* Water all plants, in accordance with Section 911.03.6, on the same Day as planting unless otherwise approved by the Engineer.

C. *Mulching.* Place a minimum of 4 inches of mulch on all areas of trees and shrubs. Place mulch the same Day of planting, unless otherwise approved by the Engineer.

D. *Wire baskets, nylon binding and treated burlap.* Cut away and remove the wire baskets, nylon binding, and burlap from the top half of the root ball.

E. *Staking and Guying.* Install all staking and guying specified on the same Day as planting and mulching, unless otherwise approved by the Engineer.

F. *Cleaning Up.* Throughout the course of planting, remove from the site all excess and waste materials, keep seeded areas clean, and take all precautions to avoid damage to existing Structures, trees, shrubs, plants, and grass. When planting in an area that has been otherwise completed, clear area of all debris, rubbish, subsoil, and remove all waste materials from the site immediately upon completion of the planting. Rake all ground surfaces smooth. Repair all sodded areas disturbed as a result of construction at no additional cost to the Department.

911.03.6 Plant Establishment. The plant establishment period for all planting begins immediately after all planting and replacements (as specified under Section 911.03.5, Planting) are complete and acceptable to the Engineer. The plant establishment period will consist of one full growing season during which time the Contractor is responsible for all Work necessary to keep the plants in a live and healthy condition. A growing season is defined as the period from May 1 through September 30. If the Contractor completes all planting in accordance with the Contract Documents by May 1, the inspection will be held on or about October 1 of that year. In the event the Contractor does not complete all planting by May 1, the inspection will be held on or about October 1 of the following year. All replacement plant Material determined to be necessary at the 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. Notify the Engineer in writing that all replacement planting has been accomplished. The Engineer will conduct an inspection within 15 Days after such notification to determine the acceptability of the replacements. If all replacements are determined satisfactory by the Engineer, the Contractor will be relieved of all further responsibility for care and replacement.

Keep all planting areas free of weeds and grass during the life of the Contract. The Contractor may utilize a pre- or post-emergent herbicide to control such grass and broadleaf weeds incidental to the cost of planting and be totally responsible for the proper use and placement of any such herbicide. Weed within all plant beds and within the saucer limits of individual plants, beginning 10 Days after the date of notification by the Engineer. 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.

Reset at the proper grades, any plants that settle below or rise above the desired finished grades.

Remove any dead or unhealthy plants within 10 Days and replace during the next appropriate planting season.

Furnish and plant all replacement plants, with plants of the same kind, size and quality as originally specified in the Contract, and as specified herein for new plant Material.

Provide a warranty in accordance with Section 911.04.1 on all plant Material against defects including death and unsatisfactory growth, except for defects resulting from incidents beyond the Contractor's control, such as vehicular impacts or vandalism. Submission of appropriate police reports or other approved evidence verifying the cause of the damage is required to relieve the Contractor of responsibility for replacement.

Water all major and minor trees, shrubs and all herbaceous beds bi-weekly during the period from June 15 through October 1. Continue watering, once initiated, without interruption until all plants on the Project have been watered. Water used for this Item shall meet the requirements of Section 1021. Tree watering bags, if utilized, shall be filled as a part of the watering operation; payment shall be as detailed herein. Tree watering bags shall remain the property of the Contractor and shall be removed prior to final inspection.

911.04 Method of Measurement. The quantity of planting will not be measured.

The quantity of watering shall be per 1,000 gallons of water applied and based on the following schedule: Major trees-15 gallons per tree, minor trees-10 gallons per tree, shrubs-5 gallons per shrub, perennials-10 gallons per 100 square feet of planting bed. The quantity of watering shall be documented on the breakout sheet provided for this Item.

911.04.1 Maintenance Bond. Furnish to the Department a Maintenance Bond upon Substantial Completion of the Work on the form provided by the Department for Item 911000 - Planting. The Maintenance Bond shall meet the following requirements:

A. A sum equal to 100% of the value of all Planting Items paid to the Contractor, as detailed in the Breakout Sheet;

B. All signatures are original signatures, in ink, and not mechanical reproductions or facsimiles of any kind;

C. The Contractor is the named principle;

D. Section 911.03.6 Plant Establishment Work Items associated with this Section requires completion after Substantial Completion of the Project. The term of the Maintenance Bond will be for a period of one full growing season, as defined in the Section, beyond the completion of permanent planting Work; and

Written by a Surety or insurance company that is in good standing and currently licensed to write surety bonds in the State of Delaware by the Delaware Department of Insurance.

911.05 Basis of Payment. The quantity of planting will be paid for at the Contract Lump Sum. 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, 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; for replacement planting; for cleanup; for repairs to plant Material, tree protection, wire, or staking; 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 Section 911.03.6; and for all labor, Equipment, tools and incidentals required to complete the Work.

The quantity of watering will be paid for in accordance with the Unit Bid Price for watering as detailed on the breakout sheet, per 1,000 gallons of water applied at each watering operation.

The breakout sheet attached to the Proposal shows all plant Material and the anticipated amount of water proposed for this Contract. Complete the breakout sheet accordingly for each Item listed. The lump sum price Bid for 911000 - Planting shall be the sum of the total cost for all Items listed.

The Department reserves the right to delete from the Contract the furnishing and installing of one or more of the species and/or sizes listed and the right to add or subtract from the quantity of each species and size listed. The lump sum to be paid will be adjusted in accordance with the Contractor's Unit Prices as required above. There will be no extra compensation to the Contractor if such additions and/or deletion are made.

Payment for the planting as described above may be processed if, in the opinion of the Engineer all Work required, except that specified under Section 911.03.6 is satisfactorily completed. No partial payment will be made for any living plant until and unless planted in accordance with these Specifications. 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 Section 911.03.6.

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 Section 911.03.6 shall be the responsibility of the Contractor.

ITEM	DESCRIPTION	UNIT
911000	PLANTINGS	LS

DIVISION 1000 – MATERIALS

1000.01 General.

Perform sampling, testing, and inspection of all Materials included in this Division in accordance with the guidelines set forth in the Department's Materials and Research Manual, latest edition, unless otherwise specified in the Contract Documents.

Submit and track the proposed sources of all Materials to be incorporated in the Project. Material not included and approved on the "Source of Supply" is not permitted to be incorporated into the Work. All source approvals are contingent on the continued production of the respective Materials meeting the requirements of the Contract Documents.

Refer to Sections 106.01 *Source of Supply and Quality Requirements* and 106.02 *Samples, Tests, and Referenced Sections* for more detailed information.

SECTION 1001 – BORROW

1001.01 Material Requirements.

Use classification, characteristics, and definitions of terms for borrow according to requirements of:

AASHTO M57

AASHTO M145

AASHTO M146

AASHTO M147

Material must have:

Maximum dry weight ≥ 90 pounds per cubic feet

Liquid Limit ≤ 40

No frozen material, rubbish, boulders in excess of 6 inches, or organics

Types and requirements in addition to above:

Table 1001-1: Dry Weight Percent Passing Square Mesh Sieves for Borrow Types

	Type A	**Type B (special fill)**	**Type C (Backfill)**	**Type D (Cement Stabilization)**	**Type F (Common Borrow)**
3”		100%		100%	Must meet general requirements listed in the paragraph above
2-1/2”	95 – 100%				
1”			85 – 100%		
No. 200	Max 35%	Max 10%	Max 25%	8 – 30%	

SECTION 1002 – CLAY BORROW

1002.01 Material Requirements.

Clay Material must be free of rubbish and organic matter and free of stones larger than 6 inches.

Material	Unified Soil Classification System designation
Clay Borrow Type 1	GC, SC, CL, CH
Clay Borrow Type 2	GC, SC, CL,

SECTION 1003 – FINE AGGREGATE

1003.01 Material Requirements.

The organic impurities requirement is waived for fine aggregate specified for uses other than in Portland Cement Concrete and masonry mortars.

Fine Aggregate Gradation Table

Sieve Size	% Passing	
	Concrete Sand	Mortar Sand
3/8” (9.5 mm)	100	
No. 4 (4.75 mm)	95 – 100	100
No. 8 (2.36 mm)		95 - 100
No. 50 (300 µm)	5 - 30	
No. 100 (150 µm)		0 - 25
No. 200 (75 µm)	0 - 3	0 - 5

SECTION 1004 – COARSE AGGREGATE

1004.01 Description.

Use crushed particles of the same origin consisting of either minimum single faced crushed gravel, coarse crushed stone, crushed slag aggregate, or recycled concrete aggregate.

1004.02 Material Requirements.

Submissions. The Engineer will sample and test. Once a stockpile of Material has been tested and approved, add no additional Material until the stockpile is depleted.

Non-Recycled (Quarried) Material Properties. Uniform in quality and free of silt, clay, decomposed fragments, overburden material, soil, reinforcement, and other deleterious debris.

Gradation. Graded aggregate material conforming to the following gradation requirements for the appropriate type:

Aggregate Size	***Sieve Size (square openings), millimeters except where noted***																	
	4" (100)	*3 ½" (90)*	*3" (75)*	*2 ½" (63)*	*2" (50)*	*1 ½" (37.5)*	*1" (25)*	*¾" (19)*	*½" (12.5)*	*⅜" (9.5)*	*¼" (6.3)*	*# 4 (4.75)*	*# 8 (2.36)*	*#10 (2.00)*	*# 16 (1.18)*	# 40 (425 *µm)*	*# 100 (150 µm)*	# 200 (75 *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					0-2
67							100	90 - 100		20 - 55		0 - 10	0 - 5					0-2
8									100	85 - 100		10 - 30	0 - 10		0 - 5			0-2
Mod #8									100	100	0 - 70	0 – 25	0 – 5					0 -1.0
10										100		85 - 100					10 - 30	
Rice										100		70 – 100		0 - 20		0-10		0-5
GABC						100		50-95				20-50		15-40			2-20	

Recycled Materials																	
RAP[1]					100												
RCA[1]					100		50-95				20-50		15-40			2-20	
RAS[2]									100								

[1] See Table below for additional requirements for RAP and RCA

Property	Range
Liquid Limit (T89)[A]	30 max
Plasticity Index (T90)[A]	4 max
Sand Equivalency[A]	25 min
Asphalt Materials[B] (RCA ONLY)	5% max
Brick[B]	5% max
Wood[B]	0.1% max
Metals[B]	0.1% max
Plaster[B]	0.1% max
Deleterious Materials[B]	0.1% max

[A]Minus 0.425 mm (#40) sieve material
[B]By weight

[2] RAS shall meet requirements of AASHTO MP 15 except as modified herein and AASHTO PP 53 shall be used for designing mixtures with RAS except as modified herein. Only pre-consumer shingles, free of all foreign material and moisture, are acceptable for use. Keep fiberglass-backed and organic felt-backed shingles separate and do not incorporate the two types of shingles into a single mix.

SECTION 1005 – GRADED AGGREGATES

1005.01 Material Requirements.

Use graded aggregates uniform in quality and free of silt, clay, decomposed fragments, overburden material, soil, reinforcement, and other deleterious debris. Los Angeles Abrasion testing, per AASHTO T96, must show percent of wear less than or equal to 45 percent.

Table 1005-1: Percentage Passing by Weight for Graded Aggregates

Sieve Size	Type B (Crusher Run)
2-1/2”	--
1-1/2”	100
1”	----
3/4”	50-95
No. 4	20-50
No. 10	15-40
No. 20	----
No. 100	2-20

SECTION 1006 – STONE FOR RIPRAP

1006.01 Material Requirements.

Use stone for riprap that is hard, durable stone free from structural defects and foreign substances such as soil, shale, and organic materials. Must be hard angular rock with width and thickness greater than or equal to 1/3 of the length. The specific gravity must be greater than or equal to 2.5 (bulk saturated, surface dry).

RIPRAP Gradation (Percent Passing (Square openings) by Weight

NSSGA* Rock Size	**R-7**	**R-6**	**R-5**	**R-4**
30”	100	----	----	----
24”	---	100	----	----
18”	15-50	----	100	----
12”	----	15-50	----	100
9”	0-15	----	15-50	----
6”	-----	0-15	-----	----
4”	-----	-----	0-15	----
3”	-----	-----	-----	0-15

*National Stone, Sand and Gravel Association

SECTION 1010 – RELEASE AGENTS

1010.01 Material Requirements.

Use asphalt release agents on truck beds, tools, and Equipment. These Materials must be non-petroleum, non-hazardous coating agents used to prevent asphalt and asphalt mix from adhering to surfaces without damaging the asphalt mix by stripping asphalt from the aggregate.

SECTION 1011 – TACK COAT

1011.01 Material Requirements.

Emulsion meeting AASHTO M316 CRS-2P cut with equal amounts of water giving a minimum asphalt content after dilution of 31 percent recovery by distillation.

For thin lift maintenance Contracts, typically less than 1-1/2 inches thick, use PG64-22 as the tack coat in lieu of emulsified asphalts.

SECTION 1012 – ASPHALT CEMENT

1012.01 Material Requirements.

Asphalt Cement (PG Graded). Per AASHTO M 320, Table 1 and tested per AASHTO R 29 with the following exceptions:

A. Original DSR will be 1.00 to 2.20 kPa,

B. Substitution of a higher upper temperature grade than specified in the contract will require prior approval by the Engineer,

C. Use of recycled materials cannot raise the low temperature properties of the combined binder above -23 ºC as tested by AASHTO T 313.

Asphalt Cement (MSCR Graded). Per AASHTO M 332 and tested per AASHTO R 29 with the following supplemental information:

A. The standard test temperature is 64^{o}C for all grades except PG 58S-28 which is 58^{o}C.

B. Highly polymer modified asphalts for Extremely High Grade, PG 64E-22, must meet the following equation, $\%R_{3.2} - (29.371 * Jnr_{3.2}{}^{-0.2633}) >/= 0.0$

C. Use of recycled Materials cannot raise the low temperature properties of the combined binder above -23 ºC as tested by AASHTO T 313.

SECTION 1013 – ANTI-STRIPPING ADDITIVES

1013.01 Material Requirements.

Use antistripping additives that are oil soluble and, when added to asphalt cement, promote strong adhesion characteristics with aggregates, compatible with the asphalt cement in which it is to be added, does not change the basic characteristics of the asphalt cement, and is heat-stable when added at the manufacturer's recommended dosage for a minimum of 96 hours at the bituminous Materials normal storage temperature. Incorporate anti-stripping additives in bituminous Materials when the Tensile Strength Ratio (TSR) as determined in accordance with AASHTO T283 is less than 80 or when specified for use by the Engineer.

SECTION 1014 – ASPHALT MATERIALS PRODUCTION

1014.01 Material Requirements.

Produce asphaltic base and surface Material as specified in the following:

Fine Aggregate	See below
Coarse Aggregate	See below
Antistripping additive	Section 1013
Asphalt Cement	Section 1012
Tack Coat	Section 1011
Recycled Asphalt Pavement (RAP)	See below
Recycled Asphalt Shingles (RAS)	See below
Mineral Filler	AASHTO M17
Warm Mix Additives	See below

1014.02.1 Fine Aggregate

Table 1014-1

Design ESALS (Millions)	Fine Aggregate Angularity (AASHTO T304) % minimum		Sand Equivalency (AASHTO T176) % minimum	Sodium Sulfate (AASHTO T104)	Deleterious Materials (AASHTO T122)
	≤ 100 mm	> 100 mm		Maximum % Loss	
< 0.3	-	-	40	20	10
0.3 to <3	40	40	40		
3 to < 10	45	40	45		
≥ 10	45	40	45		

1014.02.3 Coarse Aggregate

Conform to AASHTO M80 except no gravel, crushed gravel, or recycled concrete aggregate (RCA) used.

Table 1014-2

Design ESALS (Millions)	Coarse Aggregate Angularity (AASHTO T304) % minimum[1]		Flat and Elongated (ASTM 4791 with a 5:1 aspect ratio) % Maximum	LA Abrasion (AASHTO T96)	Sodium Sulfate (AASHTO T104)	Deleterious Materials (AASHTO T122)
	≤ 100 mm	> 100 mm		Maximum % Loss		
< 0.3	55/-	-/-	10	40	20	10
0.3 to <3	75/-	50/-				
3 to < 10	85/80	60/-				
≥ 10	95/90	80/75				

[1] XX/YY denotes that XX% of the coarse aggregate has one fractured face and YY% has two or more fractured faces

1014.02.4 RAP / RAS

The percent of recycled materials (RAP / RAS) allowed in the pavement mixture is controlled through the Materials & Research recycled mixture program available through the Materials & Research Section. The mechanically processed material must be homogenous in consistency.

Recycled Asphalt Shingles (RAS) materials must be processed so that 100% passes the 3/8" (9.5 mm) sieve. All shingles must be free of foreign material and moisture. Post-consumer shingles must be verified to be free of asbestos fibers. The deleterious materials for Recycled Asphalt Shingles (RAS) cannot exceed 1.5 percent of the total mass retained on the #4 (4.75mm) sieve.

1014.02.5 Warm Mix Additives.

Submit the following information at least 30 Calendar Days prior to production.

A. WMA technology and/or additive information.

B. WMA technology manufacturer's recommendation for usage.

C. WMA technology target dosage rate and tolerance envelope. Support tolerance envelope with test data demonstrating acceptable mix production properties conforming to all sections of this specification.

D. WMA technology manufacturer's material safety data sheets (MSDS).

E. Documentation of past WMA technology field application including points of contact.

F. Temperature ranges for mixing and compacting.

G. Laboratory test data, samples, and sources of all mix components, and asphalt binder viscosity-temperature relationships.

Follow the manufacturer's recommendation for incorporating additives and WMA technologies into the mix. Comply with the manufacturer's recommendation regarding receiving, storage, and delivery of additives.

If the producer performs blending of the WMA technology in their tank, submit a separate Quality Control Plan developed by the producer to the Department for review and approval at least 30 Calendar Days prior to production.

1014.03 Production Quality Control Plan Requirements.

Submit a Quality Control (QC) Plan to the Materials & Research Section on an annual basis for each proposed production facility for review and approval prior to Material production. The QC Plan will include actions to assure all Materials and products will conform to the Specifications, whether manufactured or processed by the Contractor, or procured from suppliers, subcontractors, or vendors. The Contractor will perform inspection and testing required to ensure product conformance to Contract requirements. Document QC inspections and tests and provide copies to the Engineer when requested. Maintain records of all inspections and tests for at least one year. Records must include the date, time, and nature of deficiency or deficiencies found; the quantities of Material involved until the deficiency was corrected; and the date, time, and nature of corrective actions taken.

The QC Plan will detail the type and frequency of inspection, sampling, and testing deemed necessary to measure and control the various properties of Material and construction governed by the Specifications. The QC Plan will include, but not be limited to, the following:

A. Production Plant - make, type, capacity, and location.

B. Production Plant Calibration - components and calibration schedule.

C. Personnel - include name and telephone number for the following individuals:

   1. Person responsible for quality control including inspection, sampling, and testing personnel

   2. Person who has the authority to make corrective actions on behalf of the Contractor.

D. Testing Laboratory - frequency calibrations of the equipment used for testing.

E. Load number of QC samples (1-10 if QA sample is not within trucks 1-10)

F. Sampling technique

G. Tests to be performed and their frequency:

1. Mixture Temperature: first five trucks and each sampled load
2. Aggregate, RAP, and RAS stockpile gradation analysis
    a. Aggregate one washed gradations per week per stockpile;
    b. RAP/RAS: five gradations and asphalt cement contents for dedicated stockpiles where new Material is not being added;
    c. RAP/RAS: one gradation and asphalt cement content test per week for stockpiles where Material is continually being added to the stockpile.
3. Gradation analysis of non-payment sieves
4. Dust to effective asphalt calculation
5. Daily moisture content analysis of aggregates.
6. Gradation analysis of the combined aggregate cold feed - one per year per mixture.
7. Bulk specific gravity and absorption of blended Material - one per year per mixture.
8. Ignition oven calibration - one per year per mixture.
9. Hot-Bins: one per year per mixture.
10. Others, as appropriate.

H. Test reporting procedures

I. Non-compliant material / work procedures.

J. Plot results of testing on control charts for each characteristic within one Working Day as results become available. Plot the following:

a. Asphalt cement content.

b. Volumetrics (air voids, voids in mineral aggregates [VMA])

c. Gradation values for the following sieves:

i. #4 (4.75 mm)

ii. #8 (2.36 mm)

iii. #200 (0.075 mm)

When any point of non-compliance with the QC plan, or Material not meeting the Specifications, comes to the attention of either the Contractor or the Engineer, notify the other party immediately. Take the appropriate corrective actions established in the approved QC plan for any non-compliance. Failure to take corrective actions immediately will be cause for rejection of Material or Work by the Engineer.

Significant violations of the QC Plan include:

A. Knowingly using out of calibration or improperly functioning Equipment.

B. Reporting false information such as test data, JMF information, or any other information.

C. Failure to perform Materials testing per the plant's approved QC Plan.

D. Deviating from AASHTO or DelDOT testing procedures.

E. Using non-approved JMF proportions or Materials.

F. Using of the wrong PG graded asphalt.

G. Failure to take corrective action per approved QC plan.

The following steps will be taken for violations listed above in addition to rejection of the Material in the case of failure to meet JMF requirements:

A. First offence: Written notice of violation to the Contractor.

B. Second offence: Within 1 year from the date of the first offence, written notice of violation to the Contractor.

C. Third offence: Within 1 year from the date of the second offence, written notice of violation and immediate suspension of the production facility until corrective actions are taken and approved by the Engineer.

D. Subsequent violations within 1 year of a third offence will follow protocol established for third offence.

1014.04 Job Mix Formulas (JMF).

Develop and submit a job mix formula for approval for each mixture according to AASHTO R35 on superpave mixture design software prior to starting production of a new mixture. Each mix design shall be capable of being produced, placed, and compacted as specified. Assign a unique identification number to each JMF.

JMF submission must include:

A. Design of component Materials

1. Source of each component and expected proportion (within 1 percent for aggregate components and 0.1 percent for other components).
2. RAP is a separate component.
3. RAS is a separate component.

B. Target characteristic values

1. Mixing temperature range
2. Core temperature range for gyration
3. Percent asphalt cement component (total and virgin)
4. Percent aggregates retained on sieve as shown in AASHTO R 35

C. Plot of the percent asphalt binder by total weight of the mix (P_b) versus

1. % G_{mm} at all N_d
2. VMA at all N_d
3. VFA at all N_d
4. Fines to effective asphalt binder (P_{be}) ratio
5. Unit weight (kg/m) at both N_d and N_m

D. Summary of the consensus property standards test results for individual aggregates in design aggregate structure.

E. Summary of source property standards test results for the individual aggregates in design aggregate structure.

F. Target value of the asphalt binder content.

G. G_{mm} table of the asphalt mixture for four trial asphalt binder contents determined according to AASHTO T 209.

H. Test data with each JMF and tests performed by a Qualified Laboratory on representative Materials verifying the design adequacy. Refer to Specifications for each mix type in order to determine the design requirements. JMF sieve percentage values conforming to the ranges shown in AASHTO R35.

I. Raw Material of each JMF so ignition oven calibration correction numbers can be established for the Engineer's and Contractor's ovens. The Engineer will provide an ignition oven correction number for each JMF.

J. Test tensile strength ratios (TSR) values on 6 inch diameter samples.

1014.04.1 JMF Design Parameters

Use combined aggregates conforming to the gradation requirement specified in the following table when tested according to AASHTO T 11 and AASHTO T 27.

Table 1014-3

	Nominal Maximum Aggregates Size Control Points, % Passing									
	25.0 mm		19.0 mm		12.5 mm		9.5 mm		4.75 mm	
Sieve Size	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
37.5 mm	100									
25.0 mm	90	100	100	-	-	-	-	-	-	-
19.0 mm	-	90	90	100	100	-	-	-	-	-
12.5 mm	-	-	-	90	90	100	100	-	100	-
9.5 mm	-	-	-	-	-	90	90	100	95	100
4.75 mm	-	-	-	-	-	-	-	90	90	100
2.36 mm	19	45	23	49	28	58	32	67	-	-
1.18 mm	-	-	-	-	-	-	-	-	30	60
0.075 mm	1	7	2	8	2	10	2	10	6	12

Note: The aggregate's gradation for each sieve must fall within the minimum and maximum limits.

The combined aggregate in the mixture must have a minimum percent moisture sensitivity per AASHTO T 283 of 80.

Satisfy the volumetric criteria of the target asphalt cement content, noted below, for the design aggregate structure:

Table 1014-4

Volumetric Property		**Target Value**	**Plant Production Tolerance**
Air Voids (V_a) at N_{design} (%)		4	±2
Voids in Mineral Aggregate (VMA) at N_{design}			
	25.0 mm Bituminous Concrete Base Course	12.5	-1.5 to +2.0 from target
	19.0 mm Type B Bituminous Concrete	13.5	
	12.5 mm Type C Bituminous Concrete	14.5	
	9.5 mm Type C Bituminous Concrete	15.5	
	4.75 mm Type C Bituminous Concrete	16.5	

The Primary Control Sieve (PCS) defines the break point of fine and coarse mixtures. Classify the combined aggregates as coarse graded when it passes below the Primary Control Sieve (PCS) control point as defined below. Classify all other gradations as fine graded.

Table 1014-5

PCS Control Point for Mixture Nominal Maximum Aggregates Size (NMAS) (% Passing)					
NMAS	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.5 mm
Primary Control Sieve	4.75 mm	4.75 mm	2.36 mm	2.36 mm	1.18 mm
PCS Control Point	40	47	39	47	30-60

For any roadway with a minimum average daily traffic volume (ADT) of 8000 vehicles and a posted speed of 35 mph or greater, the aggregate blend is required to be non-carbonate. The coarse aggregate (aggregate larger than or equal to #8 stone) must be a non-carbonate source. If RAP is used in the mixture, coarse aggregate (larger than or equal to # 8 stone) must be equal to a minimum of half the RAP percentage in the mix.

1014.04.2 Approval of JMF.

The Engineer will have up to three weeks once the JMF is submitted to review the submitted information.

1014.05 Laboratory Testing

Establish, maintain, and operate a qualified testing laboratory at the production plant site of sufficient size and layout that will accommodate the testing operations of both the Contractor and the Engineer. Laboratory facilities must meet requirements listed in LB-21 located in the Section E of Delaware Department of Transportation's Materials and Research Manual.

1014.06 Material Production Requirements. Notify the Department's Materials and Research Section of the quantity and time of scheduled release by 3:00 P.M. the day prior.

1014.06.1 Material Production Testing Equipment

Maintain all the Equipment used for handling, preparing, and testing Materials in proper operating condition. A laboratory Equipment malfunction must be remedied within one Working Day or the production will be suspended. In the case of an Equipment malfunction, the Contractor must develop a solution approved by the Engineer to allow for testing requirements to be met.

Document and maintain calibration records for the following referenced Equipment, at a minimum, in accordance to the manufacturer's guidelines:

A. SUPERPAVE Gyratory Compactor: once every year

B. Ovens: once every three months,

C. Vacuum Container and Gauge (Rice Bowls): once every three months, verified once every month.

D. Balances and Scales: once every year,

E. Thermometers: once a year; verified once every month

F. Gyratory Compactor molds and base plates: once every year

G. Mechanical Shakers: once every year

Verify sieve conditions daily by visual inspection.

Document and file all calibrations for review by the Engineer at any time.

1014.06.2 Material Production Test Methods

Perform Material production tests in accordance with the following:

A. AASHTO T312 - Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

B. AASHTO T166, Method C (Rapid Method) - Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface Dry Specimens

C. AASHTO T308 - Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method

D. AASHTO T30 - Mechanical Analysis of Extracted Aggregate

E. AASHTO T209 - Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)

1014.06.3 Plant Production.

Operate plants per the manufacturer's recommendations.

Allow 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.

1014.07 Anti-stripping Additive Blending.

If required, blend anti-strip additive per manufacturer's recommendations.

1014.08 Silo Storage Systems.

Convey mixture from the plant to the storage system without a reduction in temperature and with no segregation of the mix or oxidation of the asphalt to ensure compliance of delivered Material.

Storage of mixture is permitted for a maximum of 12 hours.

SECTION 1015 – COLD PATCH

1015.01 Material Requirements.

Produce regular cold patch, high performance cold patch, and summer cold patch capable of being stored in a stockpile for a period of at least six months without hardening or stripping and remaining workable during all expected weather conditions during this storage.

The Specification requirements below are for regular cold patch, high performance cold patch, and summer cold patch except as noted differences.

Provide Materials as specified in:

Fine Aggregate	See below and Section 1003
Coarse Aggregate	See below and Section 1004
Cutback Asphalt	Section 1011

1015.02.1 Aggregate. The aggregate employed in the target gradation of the job mix formula (JMF) is to conform to Sections 1003 and 1004, and the requirements listed below.

Table 1015-1

Test Method	Specification Limits
Toughness, AASHTO T96 Percent Loss, Maximum	40
Soundness, AASHTO T104 Percent Loss, Maximum for five cycles	20
Deleterious Materials, AASHTO T112 Percent, Maximum	10

1015.02.2 Bituminous Material. Use only an approved cold patch binder for the bituminous Material to which the temperature of the bituminous material does not exceed 170 degrees Fahrenheit or as otherwise recommended in writing by the supplier. Pipe the bituminous Material directly from the transporting tanker into the mixing plant without an intermediary holding tank.

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In addition, use only a high performance liquid that meets the following requirements:

Table 1015-2

Lab Test	Test	Specification Limit
Flash Point (^{o}F min)	ASTM D1310	200
Kinematic Viscosity@ 140^{o}F cSt (mm^{2}/s)	AASHTO T201	350 – 4,000
Percentage of Water (% max)	ASTM D95	0.2
Distillate Test (% vol. of original sample)		
To 437°F		0
To 500°F	ASTM D402	0 – 5
To 600°F		0 – 18
Residue from distillate at 680°F		72 – 95

Test on Residue from Distillate:

Table 1015-3

Lab Test	Test	Specification Limit
Absolute Viscosity@ 140^{o}F Poise (10^{-1} Pa-s)	AASHTO T202	125 – 425
Penetration (mm)	ASTM D5	180
Ductility @ 39^{o}F (min)	AASHTO T51	100
Solubility in trichloroethylene (% min)	AASHTO T	99

Use a summer cold patch mixture meeting DNREC requirements for the ozone season between May 1 – September 31.

1015.03 Production Quality Control Plan Requirements.

Not applicable.

1015.04 Job Mix Formulas (JMF).

Develop and submit Job Mix Formula meeting these requirements:

Table 1015-4

Sieve Size	% Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	55 - 90
No. 8 (2.36 mm)	10 - 25
No. 200 (0.075 mm)	0 - 3

Minimum effective asphalt binder content of 5.0 percent (allowable production tolerance of 0.4 percent) by weight of the total mixture.

1015.04.1 Mixing Requirements.

Continuously mix aggregates until free surface moisture is not present and all aggregate is thoroughly coated with asphalt Material. After mixing, stockpile Material, no higher than 5 feet, a minimum of forty-eight (48) hours at the production facility. During this period, the stockpile will be examined for runoff and workability.

1015.04.2 Approval of JMF.

Written documentation of current approval of the mix design formula by the supplier of the bituminous Material and the producer must be submitted to and approved by the Materials & Research Section prior to production. This information shall include: aggregate sources, bituminous Material source, master ranges for the gradation, and percentage of bituminous Material in the mixture. The Materials & Research Section must receive at least one Working Day advance notice prior to any mixing.

1015.05 Laboratory Testing.

Submit, for approval, the proposed mixing facility to the Materials & Research Section prior to production.

The Materials & Research Section will obtain samples of the component Materials and the produced mixture in order to test their qualities. Acceptance of the Materials and the produced mixture will be based on, but not limited to, the following described tests and considerations:

Table 1015-5

Lab Test	AASHTO	Specification Limit
Coating Test	TP40-94	> 90% Coated
Stripping Test	TP41-94	> 90% Coated
Draindown Test	TP42-94	< 8%
Workability/Storage ability Test	TP43-94	< 3 @ 40o F
Asphalt Content/Gradation Test	T-308	See Job Mix Formula

The initial approval of the Material sources, mix design, plant facilities, or mixture based on the above tests in no way precludes further examination and testing if unsatisfactory results or performance are encountered. The acceptance at the time does not bar future rejection. Performance will be judged at the time of Material use.

1015.06 Plant Production.

Operate plants per the manufacturer's recommendations.

Allow 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.

SECTION 1016 – EMULSIFIED ASPHALT

1016.01 Material Requirements.

Use emulsified asphalt that is in conformance with AASHTO M 208 for unmodified and M 316 for polymer modified with a maximum temperature of 120 degrees Fahrenheit.

1016.02 Sampling and Testing Requirements.

Sample all emulsions delivered in the presence of the Engineer in a clean plastic container provided by the Engineer. Record the date of sample, lot number, supplier and terminal, type of emulsion, supplier tank number, and gallons verified. Provide sample to the Engineer for testing. Testing is to be performed in accordance with AASHTO T59.

1016.03 Acceptance Certification Requirements.

Supply specific gravity and certificate of analysis / compliance for each shipment.

SECTION 1020 – CEMENT AND POZZOLANIC MATERIALS

1020.01 Material Requirements.

A. *Portland Cement.* Type I, Type II, Type I/II, or Type III conforming to AASHTO M 85.

B. *Blended Hydraulic Cements.* Type IP, Type IT, Type IS, or Type I(SM) conforming to AASHTO M 240 are permitted alternates to Type I or Type II cement in all classes of concrete.

C. *Fly Ash.* Class C or F conforming to AASHTO M 295 and as modified herein with total alkali content less than 3.0 percent, and a CaO content ≤ 8.0 percent. Modify requirements of Table 1 to maximum Loss on Ignition at 3.0 percent. Traces of ammonia and oil are not permitted in the fly ash.

D. *Ground Granulated Blast Furnace Slag (GGBFS).* Grade 100 or 120 conforming to AASHTO M 302.

E. *Silica Fume.* Per AASHTO M 307.

1020.02 Production and Delivery.

Use only a single brand, from a single production facility of cement or pozzolanic Material for any Contract Item. Maximum delivery temperature of cement or pozzolanic Material is 150 degrees Fahrenheit.

Manufacturer can ship under certification after testing and approval of QC Plan by the Department. The Department reserves the right at any time to sample the product, to modify the program, to withdraw certification, to require pretesting and to use reserved bins or sealed shipments.

SECTION 1021 – WATER FOR PORTLAND CEMENT CONCRETE

1021.01 Material Requirements.

Use in mixing and curing water that is clean and free of oil, salts, acids, alkalis, sugars, organics or other substances injurious to the finished product. Water known to be of potable quality may be used without testing. Where water is drawn from a surface source, enclose the intake to exclude silt, mud, organics, trash or other foreign materials.

Water must meet ASTM C1602 and ASTM C1603 with the following modifications.

Hydrogen ion concentration	4.5 to 8.5 pH
Total solids	5000 ppm maximum
Total chlorides	300 ppm maximum
Total sulfates as SO_4	500 ppm maximum
Total alkalis as $Na_2O + 0.658K_2O$	500 ppm maximum
Organic content (Test Method ASTM D4129)	2000 ppm maximum
Compressive strength, minimum at 7 days	90% of control specimen
Time of setting	+/-60 minutes from control and meeting AASHTO M 85, Vicat test

SECTION 1022 – PORTLAND CEMENT CONCRETE PRODUCTION

1022.01 Material Requirements.

Produce Portland Cement Concrete as specified in the following:

Portland Cement	Section 1020
Blended Hydraulic Cement	Section 1020
Fly Ash	Section 1020
Ground Granulated Blast Furnace Slag	Section 1020
Silica Fume	Section 1020
Water	Section 1021
Fine Aggregate	See Below
Coarse Aggregate	See Below
Fibers	See Below
Air Entrainment Agents	AASHTO M 154
Chemical Admixtures	AASHTO M 194
Lithium Admixtures	See Below
Curing Membranes	See Below

1022.01.1 Fine Aggregate.

Fineness Modulus must be 2.3 to 3.1. Conform to AASHTO M6 except the grading should be:

Sieve Size	**% Passing**
	Concrete Sand
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

1022.01.2 Coarse Aggregate.

Use coarse aggregate conforming to the requirements of AASHTO M80 except no crushed concrete (RCC) may be used. Use gravel that has a minimum of one fractured face. Los Angeles Test (AASHTO T96) percentage of wear must be less than 45 percent. Air cooled blast furnace slag must weigh 70 pounds per cubic foot or greater when tested by AASHTO T19/T19M. Conform the gradation to the requirements of AASHTO M43, or AASHTO M80 as applicable.

1022.01.3 Fibers.

Use fibers that conform to the requirements of ASTM C1116, Type III with a minimum fiber length of 1/2 inch and a maximum length of 1-1/2 inch.

1022.01.4 Lithium Admixtures.

Use only lithium admixtures certified as nonhazardous based on the heavy metal content.

1022.01.5 Curing Materials.

Use curing Materials as follows:

A. Penetrating Curing Compound with Sealer.

1. Furnish a deep penetrating silane/siloxane sealer that consists of 40 percent solids by weight either in an appropriate solvent or as a stable emulsion. The Material must be local OTC-VOC compliant.

2. The water proofing and curing Material must be a flowable, penetrating solution capable of being applied by spray or roller. The applied and cured Material must not form a film or otherwise build up on the surface of the treated surface. Follow the manufacturer's written instructions for surface preparation, application procedures, and application rates.

3. If Material is clear by nature, tint the Material with a fugitive red, blue, or green dye to enable the silane/siloxane solution to be visible on the concrete surface for at least four hours after application. The fugitive dye must not; however, be visible more than seven days after the application of the waterproofing Material. If the Material is to be tinted "on site", a test strip is to be done to determine the amount of tint is to be used per pail/drum for the project.

4. Conform to the requirements of AASHTO M148 / ASTM C 309, Type 2, Class A or B white pigmented liquid curing compounds. Wax based Material must pass a chloride screen test using NCHRP 244 Series IV (1 application @ 125 ft^2/gal) min 90 percent.

B. Sheeting – conform to the requirements of ASTM C 171.

C. Burlap – Shall be plain weave cloth made of jute or kenaf, weighing 10 ounces per square yard or greater.

D. Water – conform to Section 1021.

1022.02 Production Quality Control Plan Requirements.

1022.03 Concrete Mix Designs.

Develop and submit a mix design for each class of concrete for approval at least 30 Days before concrete production. Provide a new mix design when there is any change in the source or character of Materials used during production of concrete for the Project.

1022.03.1 Mix Design Methods.

Concrete Type	**Design Method**
Normal weight mixtures	Absolute volume method per ACI Publication 211.1
Lightweight mixtures	Select mix proportions based on trial mixes with the cement factor rather than water/cement ratio being determined by the specified strength per ACI Publication 211.2

Establish exact proportions by testing trial mixes, and adjust to produce concrete that meets plasticity and workability requirements. Show aggregate proportions in terms of saturated surface dry condition.

Conduct trial batch testing of the proposed mix and submit test results showing specified minimum strength, air content, aggregate gradation, workability requirements, permeability, and ASR expansion limits. Break histories in accordance with ACI 318M may be submitted to the Department for consideration in lieu of trial batches. The minimum sample population is 10 batches. Approval of proposed mix designs will be based upon criteria established in ACI 214 where the probability for any test property failing to meet Contract criteria is not greater than 10 percent (Probability factor (p) not less than 1.30).

Mix design submission must include, but not be limited to the following:

A. Proposed Source of Materials

B. Laboratory test data from trial batches

C. Sample of Materials used

D. Test results of the proposed aggregates for ASR reactivity from a certified lab.

1. When aggregates are ASR reactive provide test results of the proposed concrete mixture components and mitigation steps in accordance to Section 1022.03.2.B.

1022.03.2 Mix Design Parameters.

A. Water reducing admixture is required in all classes of concrete. Determine the quantity and type or combination of admixtures based on the admixture manufacturer recommendations, ambient temperature, concrete batch temperature(s), geometry of the Work, concrete mix proportions, etc.

B. Evaluate coarse and fine aggregates for use in Portland Cement Concrete for potential alkali-silica reactivity (ASR) using at least one of the means referenced in Table 1022-1 along with any field service records available for the Materials in question. If a field service record for a particular source includes evidence of deleterious ASR occurring in that source, then that source is classified as potentially reactive regardless of any laboratory test result for that source.

Table 1022-1

Tests and Criteria for Proposed Aggregate		
Procedure	**Description**	**Limit**
AASHTO T 303[(1)]	Mortar Bar Expansion	< 0.08% at 28 days
ASTM C 1293	Concrete Prism Expansion	< 0.04% at 1 year

[1] modify the w/c ratio of the mortar to 0.47

C. Class A concrete for approach slabs and Class D concrete for decks require the use of nonferrous reinforcement fibers at a rate of 1.5 pounds per cubic yard.

D. Use only Type F or Type G admixtures for slumps greater than 4 inches. The maximum allowable slump may be increased to but not exceed 8 inches.

1022.03.3 ASR Mitigation Steps. Aggregate show ASR reactivity in Table 1022-1 mitigation steps are required in the design. Mitigation steps can incorporate one, or a combination of, the following Materials:

A. Low Alkali Cement having an alkali content of 0.40 or less and a maximum of 2.5 pounds of Na_2O equivalent per cubic yard of concrete.

B. Blended hydraulic cement

C. Ground Granulated Blast Furnace Slag

D. Silica Fume

E. Fly Ash

F. Lithium Admixture at a dosage rate based upon the sodium oxide equivalent (AASHTO M 85) of the Portland cement component of the concrete.

1. Calculation of lithium dosage (100 percent) for mitigation without use of pozzolans with a 30 percent aqueous solution of lithium nitrate (lithium hydroxide and lithium chloride are not permitted). Adjust water content of the mix by removing 0.85 gallons of water per gallon of lithium solution.

a. Gallons of $LiNO_3$ / yd^3 PCC = A * B * 0.55 where

i. A = Pound of Portland cement per cubic yard

ii. B = Percent sodium oxide equivalent in cement

b. For other concentrations or different lithium salts, consult the supplier for dosage calculation.

Evaluate the effectiveness of mitigation steps by testing according to Table 1022-2. Mixtures using Low-alkali cement or 100 percent lithium dosage mitigation will be accepted without evaluation according to Table 1022-2**.** All mixture design for ASR testing will be performed by an accredited laboratory.

Table 1022-2

Tests and Criteria for Proposed Concrete Components		
Procedure	**Description**	**Limit**
ASTM C 1567 (modifed[1])	Mortar Bar Expansion	< 0.08% at 28 days
ASTM C 1293 (modifed[2])	Concrete Prism Expansion	< 0.04% at 2 years

[1]When evaluating lithium admixture, alone or in combination with ground granulated blast furnace slag, fly ash, or silica fume, use the Accelerated Mortar Bar Test (AMBT) from the Army Method CRD-C 662-09 "*Determining the potential Alkali-Silica Reactivity of Combination of Cementitious Materials, Lithium Nitrate Admixture and Aggregate"*. The maximum 28 day expansion is 0.08 percent.

[2]The modifications to ASTM C 1293 necessary to meet this table are described in the FHWA publication 'Guidelines for the Use of Lithium to Mitigate or Prevent Alkali-Silica Reaction', publication number FHWA-RD-03-047, July 2003, pages 60-62.

1022.04 Design Requirements.

Design Portland Cement Concrete to meet requirements shown in the tables below based on the intended use.

Minimum strength requirement is 2,000 pounds per square inch before the Work can be opened to vehicular traffic. The age at which this strength must be obtained will be per the Contract Schedule requirements.

Table 1022-3. Concrete Classes for Structures

Class of Concrete	**Maximum w/cm ratio lb/lb**	**Air Content (Percent)**	**Minimum 28-day Compressive Strength f'_c (psi)**	**Maximum Permeability (Coulombs)**
A	0.40	4.0 – 7.0	4,500	1,500
B	0.45	4.0 – 7.0	3,000	3,000
B/SF	0.40	4.0 – 7.0	3,500	2,500
C	0.50	4.0 – 7.0	2,000	3,500
D	0.40	4.0 – 7.0	4,500	1,500

Table 1022-4. Concrete Consistencies

Type of Work	**Nominal Slump (inches)**
Formed Elements:	
Sections< 12 inches	1 to 3
Sections ≥ 12 inches	1 to 4
Concrete placed under water	5 to 8
Filling for riprap	3 to 7
Slip Formed elements	0.5 to 2.5

1022.05 Laboratory Testing.

Provide a laboratory of 150 square feet minimum, for the exclusive use of the Engineer at all Portland Cement Concrete facilities. The producer will furnish all heat, lights, air conditioning, telephone, electric, bottled drinking water, tables, desks, chairs, filing cabinets. Furnish and maintain approved sanitary facilities.

1022.06 Material Production Requirements. Notify the Department's Materials and Research Section of the quantity and time of scheduled release by 3:00 P.M. the day prior.

1022.06.1 Handling and Storage of Materials.

A. Aggregates

1. Locate aggregate stockpiles on hard, clean, surfaces with positive drainage constructed of Materials such as Portland Cement Concrete or bituminous concrete of sufficient thickness to support the required traffic loads for this application. The base surface must be approved prior to stockpiling aggregates. If at any time the stockpile surfaces deteriorate and possibly contaminate aggregate stockpiles, concrete operations will immediately be suspended until such time as the surface is repaired to the satisfaction of the Engineer. Maintain suitable partitions to separate and contain fine and coarse aggregate stockpiles. Coarse aggregate must be stockpiled in a manner to avoid segregation.

2. Stockpile fine aggregates at the batch plant for a minimum of 24 hours prior to batching until surplus water has drained and the Material has a uniform free moisture content. Batching directly from the washing plant is prohibited. Suitable partitions must be constructed to prevent wet fine aggregates from mixing with fine aggregate used for batching.

3. Construct haul roads to the concrete plants to prevent any deleterious materials from entering the batching process. If deleterious materials are discovered anywhere in the batching process, the operation will immediately be suspended until the conditions are corrected to the satisfaction of the Engineer.

B. Cementitious Materials

1. Store cementitious Materials in suitable Structures which protect the Material from hydration.

2. Use of any cementitious Material which shows signs of hydration such as lumps or cakes is not permitted.

C. Admixtures

1. Store admixtures so that contamination, stratifications, or deterioration is prevented.
2. Agitate admixtures to supplier's recommendation.
3. When admixture dosage rates differ from the manufacturer's recommendations, discontinue the use of admixture until the cause of the problem is identified and corrected.

1022.06.2 Production Equipment Requirements.

Meet the requirements of AASHTO M 157 except as modified herein.

A. Batch Plants

1. Equip concrete batch plants for automatic batching and proportions of cement, aggregates, and water and visual observation of automatic insertion of admixtures. The plant must contain automation capable of monitoring aggregate moisture continuously during batching to make batch weight adjustments necessary for mix consistency.
   a. Weigh individual aggregates to within 1 percent of the target weight.
   b. Weigh combined aggregates to within 1 percent of the total target aggregate weight.
   c. The required batch quantity of water measured by either weight or volume must be within 1 percent.
   d. Weigh cement within +1 percent of the target batch weight.
   e. Admixture dispensers must be accurate to 1 percent of target volume.
2. Provide a computer printed ticket for each batch issued by the plant to the truck driver containing the following:
   a. Name and location of the plant.
   b. Approved mix designation.
   c. Size and proportions of the batch.
   d. Type(s) and dosage rate(s) of admixture(s) used.
   e. Batch time (determined by the time water is introduced to the mixture).
   f. Allowable water in gallons withheld from meeting the maximum allowable water/cement ratio for the approved mix design.
3. Use bins and hoppers that are in good condition and have adequate separate compartments for fine aggregates and for each required size of coarse aggregate. Design each compartment to discharge efficiently and freely into the weighing hopper. Provide means of control so that as the quantity desired in the weighing hopper is being approached, the Material may be added slowly and shut off with precision.
4. Weighing scales:
   a. Scales for weighing Material must be of rugged design, constructed to support the hopper or belts with minimum adjustments consistent with the accuracy required.
   b. Scales rated to 5,000 pounds or less measure in graduations not greater than 5 pounds.
   c. Scales rated greater than 5,000 pounds measure in graduations not greater than 0.1 percent of the maximum rated load.
   d. Maintain scales within a maximum tolerance of 0.5 percent of the net load in the hopper.
   e. Retain at least one set of the following calibration weights for verifying scale calibrations

i. Ten standard 50 pound blocks

ii. Eleven standard 20 kg blocks, one standard 5 kg block, and two standard 1 kg block.

iii. Construct the weights of high quality cast iron and finished in such a manner that foreign materials do not adhere to the surface.

iv. These weights may be checked at the Engineer's discretion.

5. Trucks for batch mix plants

a. Mix each batch greater than 70 but less than 100 revolutions at a rate of rotation specified by the manufacturer.

b. Inspect mixer drums annually for wear and have verified by the Department's Materials and Research Section.

c. Keep interior drum surfaces clean of accumulations of hardened concrete material.

d. Replace drum blades when wear exceeds 1 inch of original height.

e. Do not load truck mixers greater than the maximum gross vehicle weight.

f. Do not exceed the manufacturers rating for the size of the batch which may be transported in these units when used as an agitator.

B. Central Mix Plants

1. Central mix plants must be capable of weighing and mixing all Materials for Portland Cement Concrete before placing batches into approved transport vehicles.

2. Weigh individual aggregates to within 1 percent of the target weight.

3. Weigh combined aggregates to within 1 percent of the total target aggregate weight.

4. The required batch quantity of water measured by either weight or volume must be within 1 percent.

5. Weigh cement within +1 percent of the target batch weight.

6. Admixture dispensers must be accurate to 1 percent of target volume.

7. The minimum mixing time for batches of 10 cubic yards or less will be 60 seconds.

8. The minimum mixing time for batches greater than 10 cubic yards will be determined by the Engineer.

9. Mixing time begins when all Materials excluding mix water have been added to the mixing drum.

C. Volumetric Truck Mixers

1. Calibrate volumetric truck mixers by the Department's Materials and Research Section annually or within 12 months of being used on a DelDOT Project.

2. Equip each truck with a 1/4 cubic yard box constructed of suitable rigid materials at all times for calibration purposes.

3. Dispense cement at a constant volumetric weight equivalent during mixing operations. Calibrate aggregate bins at various gate openings to discharge the volumetric weight equivalent of aggregate required for the approved concrete mix.

4. Dispense water through a calibrated meter displaying the discharge rate into the mixing auger.

5. Provide only approved trucks capable of mixing batched Materials sufficiently to dispense a uniformly homogenous mix at the point of placement with no further mixing required.

6. The following tolerances for proportioning the various ingredients are as follows:

7. Cement: -0 percent to +4 percent of target weight

8. Fine aggregate: ±2 percent of target weight

9. Coarse Aggregate: ±2 percent of target weight
10. Admixtures: ±3 percent of target weight or volume
11. Water: ±3 percent of target weight or volume

1022.06.3 Material Production Test Methods.

The following test procedures will be used for verifying mix properties:

A. Mix Consistency (Slump): AASHTO T 119

B. Temperature of Fresh Concrete: AASHTO T 309

C. Air Content: AASHTO T 152 Modified or AASHTO T 196

D. Permeability: AASHTO T 277

E. Making and curing concrete test specimens: AASHTO T 23

F. Unit Weight: AASHTO T 121

G. Compressive Strength of Concrete AASHTO T22

1022.06.4 Mix Temperature Limitations.

A. Measure all temperatures at the point of placement.

B. The maximum allowable temperature for Class D concrete for bridge decks is 85 degrees Fahrenheit.

C. The maximum allowable temperature for all other classes of concrete is 90 degrees Fahrenheit.

D. The minimum allowable temperature for all classes of concrete is 50 degrees Fahrenheit.

E. Take appropriate actions in accordance with ACI 318 recommendations for Hot Weather Concrete when batch temperatures at the mixing plant reach 6 degrees below the maximum allowed for the class of concrete being produced.

F. Take appropriate actions in accordance with ACI 306 recommendations for Cold Weather Concrete when batch temperatures at the mixing plant reach 6 degrees above the minimum allowable for the class of concrete being produced.

1022.06.5 Delivery Time of Concrete Batches.

A. The maximum allowable elapsed time between the introduction of the mix water and the final placement for slip form mixes is 45 minutes for non-agitating transport vehicles and 60 minutes for agitating transport vehicles.

B. The maximum allowable elapsed time between the introduction of the mix water and the final placement for all other mixes is 30 minutes for non-agitating transport vehicles and 60 minutes for agitating transport vehicles.

C. The delivery time restrictions may be extended with the use of approved water reducing admixtures, set retarding admixtures, and/or replacement of a portion of the Portland cement content with Fly Ash Cement or Ground Granulated Blast Furnace Slag Cement.

D. The interval between successive loads cannot exceed the lesser of 20 minutes, or if the surface of the previous load exhibits signs of setting and cannot be mobilized through the use of mechanical concrete vibrators.

SECTION 1023 – PORTLAND CEMENT CONCRETE PATCHING MATERIAL, PARTIAL DEPTH

1023.01 Material Requirements.

Use Materials for partial depth patching of Portland Cement Concrete Structures and pavements to meet the Project requirements and needs, and as specified here-in. Submit for approval the proposed concrete mix design or pre-packaged concrete mix prior to use.

1023.01.1 Ready-Mix Concrete.

Use pre-blended packaged patch mixes that conform to the following.

A. Coarse Aggregate – Delaware No. 8 stone conforming to Section 1004 – Coarse Aggregate

B. Water – conform to Section 1021 – Water for Portland Cement Concrete

Mix pre-blended patch mixes in strict accordance with the manufacturer's proportions and recommendations, using an on-site mechanical mixer.

1023.01.2 Rapid-Set Concrete.

Use rapid-set patch Materials in strict accordance with the manufacturer's recommendations and that conform to the following.

A. Use a blend of selected Portland cements, specially graded aggregates, admixtures for controlling setting time, water reducers for workability, and an accelerator for the patch Materials.
B. Supply patch materials in a factory-blended bag/container accompanied with the manufacturer's recommendations.
C. Add aggregate to the mix conforming to ASTM C33, at a rate recommended by the manufacturer. Use Delaware No. 8 stone for this purpose as specified under Standard Specification Section 1004 – Coarse Aggregate.

Mix pre-blended patch mixes in strict accordance with the manufacturer's proportions and recommendations, using an on-site mechanical mixer.

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1023.01.3 Portland Cement Concrete. Place Class A concrete having a minimum compressive strength of 2,000 pounds per square inch (or as noted in the Contract Documents) in 6 hours as measured by Sure-Cure Mold test cylinders. Use Sure-Cure Mold test cylinders and all associated Equipment provided by the Contractor. The concrete will be sampled and tested by the Engineer. The Engineer may also use the concrete maturity meter in accordance with AASHTO T 325 to determine compressive strength. Include Material in the concrete to mitigate alkali-silica reactivity (ASR) as per Section 1022. The Contractor shall submit a concrete mix design to include the following parameters:

CONCRETE PROPERTY	SPECIFICATION
Water/Cementitious Material Ratio	0.40 (maximum)
Air Content (%)	4 - 7
Slump*	2 - 5 inch
Synthetic Fibers **	1.5 pounds per cubic yard minimum or as per manufacturer's recommendation

*Slump may be increased up to 8 inches if a Type F Admixture is utilized. Use only non-chloride based admixture Materials.

** Use synthetic fibers that are alkali-resistant polypropylene, polyethylene, or nylon with a minimum length of 1/2 inch meeting the requirements of ASTM C1116, Type III.

SECTION 1030 – BAGGED RIPRAP

1030.01 Material Requirements.

Furnish pre-mixed bagged riprap as specified in the following:

Portland Cement Concrete	See below and Section 1022
Portland cement	Section 1020
Water	Section 1021
Fine Aggregate	Section 1003
Bags	See below

1030.01.1 Portland Cement Concrete

Use a concrete mix that has a fine aggregate to cement ratio of 4:1 by weight. Dry Mix of Class B concrete per Section 1022 may be substituted.

1030.01.2 Bags

Use multi-wall paper perforated bags on approximate 1 inch center, woven polyester or polypropylene mesh bags that meet the following requirements.

- Allow passage of water but not Material leakage.
- Have adequate seal, thickness, and strength to maintain the integrity of riprap until concrete has set.
- Uniform in size, rectangular in shape, approximately 4 inch or 6 inch thick.
- Consistent in color and blend with area.
- Disintegrate with no environmental damage.
- Filled bag weight should be between 60 and 90 pounds.

Approximate size and capacity limits

Bag Type	Nominal filled Bag size	Capacity	Bags / yd^3 (Dry)
60 lb paper	4 by 12 by 18”	0.50 ft^3	54
80 lb paper	4 by 14 by 21”	0.67 ft^3	40
90 lb polypropylene	6 by 12 by 18”	0.75 ft^3	36

SECTION 1031 – PIPE CULVERTS

1031.01 Corrugated Metal Pipe.

A. Furnish steel pipe in accordance with AASHTO M 36/ M36M.

1. Furnish zinc-coated (galvanized) corrugated steel pipe in accordance with AASHTO M 218.

2. Furnish aluminum coated (type 2) corrugated steel pipe in accordance with AASHTO M 274.

B. Furnish aluminum pipe in accordance with AASHTO M 196/ M 196M.

1031.02 Structural Plate.

A. Furnish steel structural plate and associated hardware in accordance with AASHTO M 167.

B. Furnish aluminum alloy structural plate in accordance with AASHTO M 219.

C. Furnish aluminum nuts and bolts for aluminum structural plate in accordance with ASTM F468. Do not mix aluminum and steel materials unless the materials are adequately separated or protected to avoid galvanic reactions. Hot dip galvanized steel and stainless steel bolts and nuts are acceptable for connection of aluminum structural plate.

1. Furnish standard strength steel nuts and bolts in accordance with ASTM A 307. Hot-dip galvanize steel nuts and bolts in accordance with ASTM F 2329.

2. Furnish stainless steel nuts and bolts in accordance with ASTM F 594 and F 593.

1031.03 Reinforced Concrete Pipe Culverts.

A. Furnish reinforced circular concrete pipe in accordance with AASHTO M 170/ M170M. Use Class III pipe unless specified otherwise on the Plans.

B. Furnish reinforced concrete elliptical pipe in accordance with AASHTO M 207/ M 207M.

1. Designate pipe designed for placement with the major axis horizontal as horizontal elliptical pipe (HE).

2. Designate pipe designed for placement with the major axis vertical as vertical elliptical pipe (VE).

3. Use Class III for all pipe unless specified otherwise on the Plans.

C. Furnish flexible watertight gasketed joints in accordance with ASTM C 443 for pipe sizes constructed for use with rubber gaskets.

1. Ensure gasketed joints are flexible and capable of withstanding expansion, contraction, and settlement of the pipe.

2. Store rubber gaskets at 70 degrees Fahrenheit or less.

3. Lubricate rubber gaskets requiring lubrication with the lubricant recommended and supplied by the Manufacturer.

D. Provide a watertight joint using mastic compatible to materials for pipe sizes constructed where gaskets are not applicable.

E. Do not ship pipe from the plant to the Project until the requirements of AASHTO M 170/ M 170M or AASHTO M 207/ M 207M are met and the pipe is marked with the production facility's Quality Control stamp. Mark the following information clearly on the pipe prior to inspection:

1. Pipe class and dimensions

2. Pipe type – HE or VE, elliptical pipe only

3. Date of manufacture

4. Name or trademark of manufacture

All pipe inspected and approved at the manufacturing plant is subject to inspection at the Project. No previous stamp or approval will override rejection at the Project if the pipe is found to be defective or damaged.

1031.04 Thermoplastic Pipe.

A. Furnish polyethylene pipe, couplings, and fittings in accordance with AASHTO M 294 for pipes sizes 12 inch and larger. Verify compliance through the National Transportation Product Evaluation Program (NTPEP).

B. Furnish polyethylene pipe, couplings, and fittings in accordance with AASHTO M 252 for pipes sizes smaller than 12 inch.

C. Furnish joints for all pipes and fittings that use a watertight bell/spigot or bell/bell coupler in accordance with ASTM F 477. The joint system must be certified to meet a 10.8 pounds per square inch laboratory test per ASTM D 3212.

D. Furnish poly vinyl chloride (PVC) pipe in accordance with AASHTO M 278, AASHTO M 304, ASTM F 679, or ASTM F 794.

E. Furnish fiberglass pipe in accordance with ASTM D 3262.

1031.05 Steel Reinforced Thermoplastic Pipe.

A. Furnish steel reinforced thermoplastic pipe in accordance with AASHTO MP 20.

1031.06 Chemical Sealing.

A. Furnish chemical sealing (grouting) Materials in accordance with NASSCO Specification, Chemical Sealing (Grouting) Materials. Submit Materials and mix to the Engineer for approval. Mix, handle, and apply all Materials in accordance with the Manufacturer's recommendations.

SECTION 1032 – PILE MATERIALS

1032.01 Description.

Provide Materials for 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 as specified herein.

1032.02 Timber Pile Materials.

1032.02.1 Classification.

Use any species of wood that satisfactorily withstands driving for untreated timber piles that will be below water level at all times.

Provide untreated timber piles for use in exposed Work with a diameter of heartwood at the butt not less than 80 percent of the required diameter of the pile. Use southern yellow pine or Douglas fir for treated timber piles, unless otherwise specified.

1032.02.2 Requirements.

Cut all piling from sound, live timber. Do not use timber that contains unsound knots. Sound knots will be allowed provided the diameter of the knot does not exceed the lesser of 4 inches or one-third the diameter of the pile at the point where the knot occurs. Do not use timber with any defect or combination of defects, which impairs the strength of the pile more than that of the maximum allowable knot. Saw the butts square. Saw the tips square or taper to a point not less than 4 inches square where soil conditions warrant pointing the tip. Limit the slope of the spiral grain, if present, so that it does not exceed 1 inch in height for 12 inches in length.

Provide piles with a uniform taper from butt to tip. Reject any pile in which a line drawn from the center of the butt to the center of the tip falls outside the center of the pile at any point more than 0.5 percent of the length of the pile. Reject piles with bends which may cause difficulty in driving.

Do not use piles with season checks which penetrate more than one-sixth of the diameter of the pile or are more than 1/4 inch 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.

1032.02.3 Preparation.

Remove the outer bark from untreated piles. Remove by peeling all the outer bark and at least 80 percent of the inner bark from treated piles. Do not leave any strip of inner bark on the pile over 3/4 inch wide or over 8 inches long, and ensure that there is at least 1 inch of clean wood surface between any two such strips.

1032.02.4 Dimensions.

Measure the diameter that designates the size of piles 3 feet from the butt. Use piles with a minimum tip diameter of 8 inches for piles under 40 feet in length and 7 inches for 40 feet and longer piles. Measure all dimensions under the bark. Do not exceed a maximum diameter of 20 inches at butt of any pile.

1032.02.5 Preservation Treatment.

If specified, treat piles with preservative treatment in accordance with AASHTO M 133 and the AWPA preservation standards specified therein. Use CCA applied with the full-cell or modified full-cell method unless otherwise specified. Treat piles to be used on land, in freshwater or in foundations with a retention rate of 0.8 pounds per cubic foot for Southern Pine and with a retention rate of 1.0 pounds per cubic foot for Douglas Fir. Treat piles to be exposed to a marine environment with a retention rate of 2.5 pounds per cubic foot for Southern Pine. Do not use piles made of Douglas Fir in a marine environment.

1032.02.6 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 are also subject to inspection at the site of the Work. If the pile is found defective, it will be rejected.

1032.02.7 Storing and Handling.

Handle piles in accordance with Section 605.03.1. Field protect all cuts, holes, and injuries of the surface of treated Material by brushing, spraying, dipping, soaking, or coating. Ensure that all injuries, such as abrasions and nail and spike holes, are thoroughly saturated with the field-treating solution. Do not cut or trim treated piles in any manner after they are driven other than to saw off the tops as hereinafter specified. Treat holes bored in pressure treated Material by pouring them full of preservative. Treat horizontal holes, such as those for sway brace bolts, by pouring the preservative into them with a bent funnel. Fill all holes made for determining penetration and retention of preservatives with tight fitting treated cylindrical plugs.

1032.03 Cast-in-place Concrete Pile Materials.

1032.03.1 Shells (Steel Casings).

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, use steel pipe pile shell conforming to the requirements of ASTM A 252, Grade 2 with a minimum wall thickness of 1/4 inch. For welded pipe piles, provide seams that are straight or spiral-butt welded having full strength welded joints. Seamless steel pipe piles are also acceptable. Equip all piles with cast steel, inside-flange, extra strong, ribbed 60 degree conical points. Securely fit the conical points 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 1/4 inch is permissible. If the protrusion exceeds 1/4 inch, grind the protruding weld flush with the outside surface of the pile shell.

If fluted steel pile shells are used, provide a tapered section with a tip diameter of 8 inches with a closed conical point and taper rate of 0.4 inch per foot. Provide fluted steel piles closed or open ended as specified on the Plans. Splice piles 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 inch fillet weld. Perform welding with 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. Use steel shells conforming to SAE 1010 or 1015 and have a minimum yield point of 50,000 pounds per square inch and a minimum thickness of 7 gage.

Construct all field splices to have the full strength of the sections they connect. Keep a minimum distance of 40 feet between field splices when possible. Obtain approval from the Engineer for all field splices.

1032.03.2 Protective Coating.

When indicated on the Plans, protect the pile shells (steel casings) with a coating consisting of either coal tar epoxy or fusion bonded epoxy.

If coal tar epoxy coating is specified, apply two coats of dark red coal tar epoxy. Thoroughly dry and commercially blast clean the pile shell according to SSPC-SP 6 before coating. Perform the two coat application, final drying time, touch-up, and inspection in conformance to the Specifications of the SSPC. Provide a dry film thickness of each coat of 8 mils minimum and 16 mils for the two-coat system.

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If fusion bonded epoxy coating is specified, provide 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

Apply the fusion bonded epoxy coating in an environmentally controlled plant that is fully enclosed. Ensure that the blast cleaning apparatus and the coating application system are approved and prequalified by the Department. Blast clean all surfaces to be coated in accordance to SSPC-SP 5 "White Metal Blast Cleaning" standards. Achieve a blast profile of 2 to 3 mils. Measure surface profile in accordance with ASTM D4417. Submit repair procedure should blast profile exceed the requirements. Apply the coating within eight hours after blast cleaning. Apply the coating as an electrostatically charged dry powder sprayed onto the grounded pile. Heat and cure the coating in accordance with the manufacturer's recommended procedures to provide a fully cured finish. Apply the coating to a cured thickness of 25±2 mils as tested in accordance with ASTM D 7091.

For both the coal tar and fusion bonded epoxy coatings, provide a compatible touch-up compound for repairing areas damaged during driving. Apply the touch-up compound by the Contractor to all visible open areas in accordance with the manufacturer's recommended procedures.

Apply a protective coating to the length of each pile, test pile and production pile, as specified and in accordance with the Contract Documents when a protective coating is required for the production piles.

1032.03.3 Portland Cement Concrete.

Use Portland cement concrete conforming to the requirements of Section 1022, Class B.

1032.03.4 Bar Reinforcement.

Use bar reinforcement conforming to the requirements of Section 611.

1032.03.5 Storage and Handling.

Store and protect the pile casings or shells to avoid dents, abrasions, and other injuries and pick up in a manner that will avoid bending and distortion. If the pile shells are damaged due to improper storage or handling, they will be rejected.

1032.03.6 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 are subject to inspection at the Project site prior to driving. All defective piles will be rejected.

1032.04 Steel H Pile Materials.

1032.04.1 Material Requirements. Submit mill certifications for approval. Unless otherwise indicated, use only steel H piles conforming to the requirements of ASTM A36. Use Materials for splices or reinforced tips of the same as the H pile except that cast steel may be used for tips. Welding to be performed in accordance with Section 1039. Use steel that is straight and true with the camber and sweep within the permissible mill tolerances.

1032.05 Precast, Prestressed Concrete Pile Materials.

1032.05.1 Portland Cement Concrete. Use Portland cement concrete for square prestressed concrete piles conforming to the requirements of Sections 610 and 1022 as amended herein, and with a *f*'c of 6,000 pounds per square inch, unless noted otherwise on the Plans. Develop and submit concrete mix design, according to the requirements of Section 1022 for approval.

1032.05.2 Prestressing Strands. Furnish **p**restressing strands that are seven-wire stress relieved, strands conforming to the requirements of AASHTO M 203/M 203M, Grade 270, unless noted otherwise on the Plans. Arrange and stress the prestressing strands per the Contract Documents.

1032.05.3 Spiral Reinforcing. Use spiral reinforcing conforming to the requirements of AASHTO M 32 / M 32M.

1032.05.4 Bar Reinforcement. Use bar reinforcement, if required, conforming to the requirements of Section 611, Grade 60.

1032.05.5 Fabrication. Furnish piles with flat tips as indicated in the Contract Documents. Pointed pile tips are not permitted, unless specifically called for on the Plans. Furnish prestressed concrete piles with the following tolerances permitted:

Width	-1/4" to +1"
Head Out of Square	1/4" per 12' of width, measured diagonally
Horizontal Alignment (Deviation from straight line parallel to centerline of pile)	1/8" per 10' of pile
Position of Stirrup Bars and Spirals	+3/4", maintain specified clearance
Position of Tendons	+/-1/4"
Position of Handling Devices	+/-6"

1032.06 Steel Sheet Pile Materials.

1032.06.1 Material Requirements. Submit mill certifications for approval. Furnish steel sheet piles conforming to the requirements of AASHTO M 202.

For galvanized sheet piles, galvanize in accordance with Section 1039.10.

SECTION 1033 – ACCESS TUBES FOR CROSSHOLE SONIC LOG TESTING

1033.01 Material Requirements.

Access tubes for crosshole sonic log testing must be steel pipe of 0.145 inches minimum wall thickness and at least 1-1/2 inch inside diameter. Galvanized steel access tubes are not allowed unless otherwise approved by the Engineer.

The access tubes must have a round, regular inside diameter free of defects and obstructions, including all pipe joints, in order to permit the free, unobstructed passage of 1.3 inch maximum diameter source and receiver probes used for the crosshole sonic log tests. The access tubes must be watertight, free from corrosion, and with clean internal and external faces to ensure good bond between the concrete and the access tubes. Fit the access tubes with watertight threaded caps on the bottom and the top.

SECTION 1034 – CASINGS

1034.01 Material Requirements.

All permanent structural casing must be of steel conforming to ASTM A 36 or ASTM A 252 Grade 2 unless specified otherwise in the Contract Documents. Splice permanent structural casing in accordance with Section 6.13.6 of the AASHTO LRFD Bridge Design Specifications, 2014 Edition.

The diameter of permanent casing will be as shown in the Contract Documents, unless a larger diameter casing is approved by the Engineer. When a larger size permanent casing is approved by the Engineer, no additional payment will be made for the increased weight of casing steel, or the increased quantity of drilled shaft excavation and concrete.

All permanent casing must be of ample strength to resist damage and deformation from transportation and handling, installation stresses, and all pressures and forces acting on the casing. For permanent nonstructural casing, corrugated casing may be used.

Where the minimum thickness of the casing is specified in the Contract Documents, it is specified to satisfy structural design requirements only. Increase the casing thickness from the minimum specified thickness, as necessary, to satisfy the construction installation requirements.

All temporary casing must be a smooth wall structure steel, except where corrugated metal pipe is shown in the Plans as an acceptable alternative material. All temporary casing must be of ample strength to resist damage and deformation from transportation and handling, installation and extraction stresses, and all pressures and forces acting on the casing. The casing must be capable of being removed without deforming and causing damage to the completed shaft, and without disturbing the surrounding soil.

The outside diameter of temporary casing may not be less than the specified diameter of the shaft.

All casing must be watertight and clean prior to placement in the excavation.

Completely remove temporary casing, unless otherwise shown on the Plans or approved by the Engineer.

SECTION 1035 – SLURRY

1035.01 Mineral Slurry.

Use mineral slurry in conformance with the Drilled Shaft Installation Plan as specified in Section 606.03.1.B.

Mineral slurry must conform to the following requirements:

Table 1035-1 Mineral Slurry Requirements.

Property	Test	Requirement
Density (pcf)	Mud Weight (Density) API RP 13B-1, Section 1	64.3* to 72*
Viscosity (seconds/quart)	Marsh Funnel and Cup API RP 13B-1, Section 2.2	28 to 50
pH	Glass Electrode, pH Meter (ASTM E70), or pH Paper	8 to 11
Sand Content (percent) immediately prior to placing concrete	API RP 13B-1, Section 5	4.0 max

* When approved by the Engineer, slurry may be used in salt water, and the allowable densities may be increased up to 2 pounds per cubic foot. Slurry temperature must be at least 40 degrees Fahrenheit when tested.

1035.02 Polymer Slurry.

Use polymer slurries, either natural or synthetic, in conformance with the manufacturer's recommendations, and conform to the Drilled Shaft Installation Plan as specified in Section 606.03.1.B.

The polymer slurry must conform to the following requirements:

Table 1035-2 Polymer Slurry Requirements.

Property	Test	Requirement
Density (pcf)	Mud Weight (Density) API RP 13B-1, Section 1	64* pcf max.
Viscosity (seconds/quart)	Marsh Funnel and Cup API RP 13B-1, Section 2.2	32 to 135
pH	Glass Electrode, pH Meter (ASTM E70), or pH Paper	8 to 11
Sand Content (percent) immediately prior to placing concrete	API RP 13B-1, Section 5	1.0 max**

* When approved by the Engineer, polymer slurry may be used in salt water, and the allowable densities may be increased up to 2 pounds per cubic foot.

** The sand content of polymer slurry prior to final cleaning and immediately prior to placing concrete must be less than or equal to 1.0 percent, in accordance with American Petroleum Institute API RP 13B-1, Section 5. Slurry temperature must be at least 40 degrees Fahrenheit when tested.

1035.03 Water Slurry.

Water may be used as slurry when casing is used for the entire length of the drilled hole, provided that the method of drilled shaft installation maintains stability at the bottom of the shaft excavation.

Water slurry must conform to the following requirements:

Table 1035-3 Water Slurry Requirements.

Property	Test	Requirement
Density (pcf)	Mud Weight (Density) API RP 13B-1, Section 1	64 pcf max.
Sand Content (percent)	API RP 13B-1, Section 5	1.0 max.

SECTION 1036 – ADDITIONAL CONCRETE REQUIREMENTS FOR DRILLED SHAFTS

1036.01 Material Requirements.

Furnish a concrete mix as specified in the Contract Documents and in conformance with Section 1022 and as amended herein:

A. Comply to the following concrete slump requirements:

1. Dry placement methods: 5 to 7 inches
2. Casing removal methods: 8 to 10 inches
3. Tremie Placement methods: 8 to 10 inches

B. Slump loss to less than 4 inches is not permitted during the period equal to the anticipated pour period plus two hours. Slump life may be extended through the use of retarders and mid-range water reducers with the approval of the Engineer.

SECTION 1037 – EMBEDDED REINFORCEMENT AND HARDWARE

1037.01 Uncoated Reinforcement.

A. Furnish billet-steel bar reinforcement in accordance with AASHTO M 31, Grade 60 or ASTM A 706, Grade 60.

B. Furnish deformed steel wire in accordance with AASHTO M 225.

C. Furnish welded plain steel wire fabric in accordance with AASHTO M 55.

D. Furnish plain steel wire in accordance with AASHTO M 32.

E. Furnish deformed steel welded wire reinforcement in accordance with AASHTO M 221.

F. Furnish zinc allow wire in accordance with ASTM A1055.

1037.02 Coated Reinforcement.

A. Furnish epoxy-coated bar reinforcement in accordance with AASHTO M31 and ASTM A775. All exposed surfaces shall be epoxy-coated.

B. Furnish epoxy-coated wire and welded wire fabric in accordance with AASHTO M55 and ASTM A 884, Class A.

C. Accompany each shipment of epoxy-coated reinforcing steel with a Certificate of Compliance signed by the applicator of the coating certifying that the above requirements are met.

D. Furnish galvanized bar reinforcement in accordance with ASTM A 767 with a zinc coating conforming to ASTM B6.

E. Furnish zinc and epoxy dual-coated bar reinforcement in accordance with ASTM A 1055. The optional submittals laid out in Sections 5.3, 5.4, and 5.5 of ASTM A 1055 are required.

1037.03 Stainless Steel Reinforcement.

A. Furnish stainless steel bar reinforcement in accordance with ASTM A 955. Do not mix multiple stainless steel types on the same project.

1037.04 Pavement Hardware.

A. *Tie Bars.* Furnish tie bars in accordance with AASHTO M 31 or AASHTO M 322. Do not use rail-steel for tie bars to be bent and restraightened during construction.

B. *Plain Dowel Bars.* Furnish plain round dowel bars and load transfer assemblies in accordance with AASHTO M 255 (ASTM A675), Grade 65. Provide coating in accordance with ASTM A775.

C. *Coated Dowel Bars.* AASHTO M 31 and ASTM A775. Type A or Type B as referenced on the Plans.

1037.05 Other Hardware.

A. *Splice Couplers.* Furnish splice couplers in accordance with AASHTO M 31.

B. *Epoxy Coated Splice Couplers.* Furnish epoxy coated splice couplers in accordance with AASHTO M31 and ASTM A775.

C. *Tie Bars, Hook Bolts, W-bolts.* AASHTO M 31.

D. *Fiber Reinforcement.* Alkali resistant per ASTM C 1116, Type III with a minimum fiber length of 1/2 inch and a maximum length of 1-1/2 inch.

SECTION 1038 - PRESTRESSING STRANDS

1038.01 Material Requirements.

Unless otherwise indicated in the Contract Documents, use strand conforming to the following requirements:

Nominal Diameter of Strand, (inches)	Minimum Breaking Strength of Strand, (lbf)	Minimum Load at 1% Extension, (lbf)	Minimum Elongation at Breaking Strength, (%)
0.500	41,300	31,170	3.5
0.600	58,600	52,740	3.5

1038.01.1 Uncoated Strands. Use prestressing strands that are uncoated high-strength seven-wire low-relaxation strand, with nominal 0.5 or 0.6 inch diameter (referred to as strand designation no. 13 and 15 in AASHTO M203) in accordance with the Contract Documents and AASHTO M203, Grade 270, low-relaxation. The use of stress-relieved type strands is not permitted.

1038.01.2 Post-Tensioning Strands. Use ½ inch diameter, 7-wire, uncoated, low-relaxation strands for unbonded post-tensioning, confirming to AASHTO M203, Grade 270. Encase strands in polymer sheathing. Use corrosion inhibitor recommended by the manufacturer between the strand and sheathing. Provide anchorages, bearing devices, fittings and couplings as shown on the plans and specified by the tendon manufacturer.

SECTION 1039 – STRUCTURAL STEEL

1039.01 Structural Steel.

A. *General*. Furnish the grade or grades of steel as specified in the Plans.

Ensure that the steel used in the main load carrying member components that are subject to tensile stress meets the applicable AASHTO M 270 Charpy V-Notch Impact Test requirements for Zone 2 unless otherwise specified.

B. *Carbon Steel*. For carbon steel, meet AASHTO M 270, Grades 36 or 50S.

C. *High-Strength, Low-Alloy Structural Steel*. For high-strength, low-alloy structural steel, meet AASHTO M 270, Grades 50 or 50W.

D. *High-Strength, Low-Alloy, Quenched-and-Tempered Steel Plate*. For high-strength, low-alloy, quenched-and-tempered steel plate, meet AASHTO M 270, Grade 70W.

E. *High-Yield-Strength, Quenched-and-Tempered Alloy Steel Plate*. For high-yield-strength, quenched-and-tempered alloy steel plate, meet AASHTO M 270, Grades 100 or 100W.

For quenched-and-tempered alloy steel structural shapes and seamless mechanical tubing, meet AASHTO M 270, Grade HPS 100W steel, except that the specified maximum tensile strength may be 140,000 psi for structural shapes and 145,000 pounds per square inch for seamless mechanical tubing.

F. *High-Strength, Low-Alloy, High Performance Steel (HPS) Structural Steel Plate.* For high-strength, low-alloy, high performance steel (HPS) structural steel plate , meet AASHTO M 270, Grades HPS 50W, HPS 70W, or HPS 100W.

G. *Steel for Eyebars*. For eyebars, meet AASHTO M 270, Grades 36, 50, 50W, or HPS 50W.

1039.02 Fasteners.

A. *Bolts for General Application.* For general application bolts, meet ASTM A 307, Grade A.

1. U-Bolts. ASTM A449, Type 1.

B. *Nuts.* For nuts, meet ASTM A 563.

C. *Washers.* For washers, meet ASTM F 436 or ANSI B18.22.

D. *Hardware for Wood Connectors.* For wood connector hardware, meet ASTM A 711 or AISI No. 1015.

1039.03 High Strength Fasteners.

A. *High Strength Bolts and Bolting Materials*. For structural steel joints, provide high-strength bolts that meet either ASTM A 325 or ASTM A 490. Ensure that the hardness of ASTM A 325 bolts does not exceed 33 HRC. For unpainted weathering grades of steel, use Type 3 bolts. Use only nuts (ASTM A563) and washers (ASTM F436) that are compatible with the required bolt type, as identified below.

Ensure that the supplier provides the lot number on the shipping package and a certification identifying the date and location of all testing. Include rotational capacity tests and bolt and nut coating thickness, when applicable. Provide results of the following tests:

1. Proof load tests of bolts performed according to ASTM F 606, Method 1.
2. Wedge tension tests of full-size bolts performed according to ASTM F 606.
3. Proof load tests of nuts as required by ASTM A 563.

Ensure galvanized bolts are wedge tested after galvanizing. Perform proof load tests for nuts used with galvanized bolts after galvanizing, overtapping and lubricating.

For ASTM A 325 bolts, provide nuts meeting ASTM A 563, Grades C, C3, D, DH, or DH3.

For ASTM A 490 bolts, provide nuts meeting ASTM A 563, Grades DH or DH3.

Lubricate galvanized nuts with a lubricant containing a visible dye. Ensure black bolts are oily to the touch when delivered and installed.

Furnish washers of hardened steel meeting ASTM F 436.

B. *Stainless Steel Bolts and Nuts*. Provide bolts meeting ASTM F 593, alloy groups 1, 2, or 3, and nuts meeting ASTM F 594.

C. *Identifying Marks*.

1. Ensure ASTM A 325 fasteners have the following markings, as applicable.

   a. *Bolts and Nuts*. Mark bolt heads to identify the grade (by the symbol "A 325"), the manufacturer, and the type (if Type 3). Mark nuts to identify the grade, the manufacturer, and the type (if Type 3).

   b. *Direct Tension Indicators*. Mark direct tension indicators to identify the manufacturer and the type ("325").

   c. *Washers*. Mark washers to identify the manufacturer and the type (if Type 3).

2. Ensure ASTM A 490 fasteners have the following markings, as applicable.

   a. *Bolts and Nuts*. Mark bolt heads to identify the grade (by the symbol "A 490"), the manufacturer, and the type (if Type 3). Mark nuts to identify the grade, the manufacturer, and the type (if Type 3).

   b. *Direct Tension Indicators*. Mark direct tension indicators to identify the manufacturer and the type ("490").

   c. *Washers*. Mark washers to identify the manufacturer and the type (if Type 3).

D. *Dimensions*. Ensure bolt and nut dimensions meet the Heavy Hexagon Structural Bolts and Heavy Semi Finished Hexagon Nuts requirements in ANSI B18.2.1 and B18.2.2, respectively.

E. *Galvanizing*. Perform in accordance with Section 1039.10 and as specified herein.

1. Do not galvanize ASTM A 490 bolts.

2. For Type 1 ASTM A 325 fasteners, mechanically galvanize according to ASTM B 695, Class 55.

3. Tension test bolts after galvanizing.

F. *Alternate Fasteners*. Obtain approval to use fasteners or fastener assemblies that differ from the Contract Documents. Ensure that alternate fasteners meet the materials, manufacturing, and chemical composition requirements of ASTM A 325 or ASTM A 490 and the mechanical property requirements of the same specification in full size tests, and 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 the same nominal dimensions prescribed.

Approved alternate fasteners may differ in other dimensions from those of the specified bolts and nuts.

Obtain approval to use high-strength steel lock-pin and collar fasteners, as an alternate for the specified high-strength bolts. Submit documentation of the following information:

1. The shank and head meet the requirements of Section 1039.02.A.

2. Each fastener provides a solid shank body of sufficient diameter to provide tensile and shear strength equivalent to or greater than that of the bolt specified.

3. A cold-forged head on one end, of adequate type and dimensions.

4. A shank length suitable to fasten the Material, locking grooves, breakneck groove, and pull grooves (all annular grooves) on the opposite end.

5. A steel locking collar of proper size for shank diameter used, that, by means of suitable installation tools, is cold swaged into the locking grooves forming head for the grooved end of the fastener after the pull groove section has been removed.

6. The steel locking collar is a standard product of an established manufacturer of lock pin and collar fasteners.

1039.04 Anchor Bolts.

A. *Anchor Bolts.* For anchor bolts, meet AASHTO M 314, Grades 36, 55, 105. Mechanically galvanize as specified in Section 1039.10.

B. *Nuts.* For nuts, meet ASTM A 563.

C. *Washers.* For washers, meet ASTM F 436.

1039.05 Welded Shear Connectors.

A. *Materials*. Furnish stud shear connectors meeting the requirements of AASHTO M 169, cold drawn bars, UNS Designations G 10150, G 10180, or G 10200, either semi- or fully kilned. When flux retaining caps are used, ensure that steel used for the caps is a low- carbon grade suitable for welding and that meets ASTM A 109 requirements.

Meet Table 1039.05-1 requirements with bar stock used to produce finished studs. Determine yield by the 0.2 percent offset method.

Table 1039.05-1. Tensile Properties of Stud Shear Connectors

Property	Requirement
Tensile strength, minimum	60,000 psi
Yield strength, minimum	50,000 psi
Elongation, minimum	20% in 2 in.
Reduction of area, minimum	50%

B. *Dimensions*. Furnish stud shear connectors meeting the dimensions of Table 1039.05-2 Stud Shear Connectors Standard Dimensions and Tolerances.

Table 1039.05-2. Stud Shear Connectors Standard Dimensions and Tolerances (in inches)

Shank		*Head*	
Diameter (c)	*Length* (L)*	*Diameter (H)*	*Thickness (T)*
0.75	6	1.25	
+0.000 to -0.015	+0.062 to -0.125	+0.015	0.375 minimum
7/8	6	1.75	
+0.000 to -0.015	+0.062 to -0.125	+0.015	0.375 minimum

* Length includes thickness of head.

C. *Test Methods*. Determine tensile properties according to the applicable sections of AASHTO T 244. Perform tensile tests on finished studs welded to test plates using the test fixture in Figure 7.2 of AASHTO / AWS D1.5. Repeat the test if fracture occurs outside the middle half of the gauge length.

D. *Finish*. Furnish finished studs of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, or other defects. Produce a finish by cold drawing, cold rolling, or machining.

E. *Certification*. Furnish the manufacturer's certification that the delivered studs meet Material requirements. Furnish certified copies of in-plant quality control test reports with delivered product.

F. *Quality Assurance*. The Engineer may select, studs of each type and size to verify compliance with the specified requirements. Replace components at the Contractor's expense.

1039.06 Steel Forgings and Steel Shafting

A. *Steel Forgings*. For steel forgings, meet AASHTO M 102, Classes C, D, F, or G.

B. *Cold-Finished Carbon Steel Shafting*. For cold-finished carbon steel shafting, meet AASHTO M 169, Grades UNS Designations G 10160 to G 10300, inclusive.

1039.07 Castings.

A. *Steel Castings*.

1. *Steel Castings*. For steel castings, meet AASHTO M 103, Grade 70–36.

2. *Chromium Alloy Steel Castings*. For chromium alloy steel castings, meet AASHTO M 163, Grade CA 15M.

B. *Iron Castings.*

1. *Gray Iron Castings.* For gray iron castings, meet AASHTO M 105, Class 30.

2. *Ductile Iron Castings.* For ductile iron castings, meet ASTM A 536, Grade 60-40-18. Furnish specified test coupons per ASTM A1067, and test specimens from integral casting parts, such as risers, for castings with a weight exceeding 1,000 pounds.

3. *Malleable Iron Castings*. For malleable iron castings, meet ASTM A 47, Grade 32510.

Clean scale and sand from all castings before delivery.

1039.08 Pipe and Tubing.

A. *Steel Pipe*.

1. *Pipe and Couplings*. For pipe and couplings, meet ASTM A 53.

2. *Flanges and Pipe Fittings*. For flanges and pipe fittings, meet ASTM A 338.

3. *Weld Fittings*. For weld fittings, meet ASTM A 234.

B. *Low-Alloy Steel Pipe*.

1. *Pipe and Couplings.* Manufacture pipe and couplings from low-alloy steel AASHTO M 270, Grade 50 or 50W, Type 2 or AASHTO M 270 Grade 50W, and conforming to ASTM A 53.

2. *Flanges and Pipe Fittings.* For flanges and pipe fittings, meet ASTM A 338.

3. *Welding Fittings*. For weld fittings, meet ASTM A 234.

C. *Cast Iron Pipe*. For cast iron pipe, meet ASTM A 74 or ASTM A 377.

D. *Steel Tubing.* For steel tubing, meet ASTM A 500 or ASTM A 501.

E. *Sign Structure Pipe.* For sign structure pipe, meet one of the following:

1. ASTM A 53, Grade B, Type E or S

a. Provide Charpy V-notch testing (Zone 2) for pipe with wall thicknesses greater than or equal to ½ inch.

2. API Specification 5L, Grade B, X42 or X52; PSL2 with the following characteristics:

a. No jointers permitted.

b. Do not use thermomechanical rolled or thermomechanical formed (grade suffix M) pipe on monopipe structures.

c. Process of manufacture: seamless, electric resistance welded, or longitudinal seam, submerged arc welded.

d. Provide Charpy V-notch testing (Zone 2) for pipe with wall thicknesses greater than or equal to 1/2 inch.

3. ASTM A 500, Grade B

a. Provide Charpy V-notch testing (Zone 2) for pipe with wall thicknesses greater than or equal to 1/2 inch.

4. ASTM A 106, Grade B

a. Provide Charpy V-notch testing (Zone 2) for pipe with wall thicknesses greater than or equal to 1/2 inch.

1039.09 Metal Sheeting.

A. *Metal Bridge Deck Forms.* Use permanent forms, fabricated from steel conforming to ASTM A 924 and ASTM A 653 (Structural Steel (SS) excluding Grade 50 Class 3), with a coating designation of G165, and a minimum thickness of 20 gage. Coat fasteners, if used, by galvanizing according to ASTM A 153 or ASTM B 633, Thickness Class Fe/Zn 12.

B. *Sheet Copper*. For sheet copper, meet ASTM B 152, and conforming to the requirements of the Embrittlement Test, Section 12 of ASTM B 152 and ASTM B 577. Make lapped joints by soldering or by riveting.

C. *Sheet Zinc*. For sheet zinc, meet ASTM B 69, Type II. Make lapped joints by soldering.

D. *Steel Sheet.* For steel sheet, meet ASTM A 653 Designation G-90.

1039.10 Galvanizing

A. *General*.

1. If indicated or specified, galvanize materials as specified in the applicable material specifications. If the applicable material specifications do not include galvanizing, galvanize according to: AASHTO M 111, AASHTO M 232, ASTM B 633, ASTM A 392 Class 2 coating, ASTM B 695, as applicable.

2. Test for the specified weight of galvanizing according to AASHTO T 65.

3. Comply with ASTM A 143 and ASTM A 385.

B. *Repair of Damaged Galvanizing*. Repair damaged galvanizing in accordance with ASTM A 780.

C. Use the same process to galvanize the washers, nuts, and bolts of any assembly.

D. Overtap nuts the minimum amount required for the fastener assembly. Lubricate galvanized nuts with a lubricant containing a visible dye.

SECTION 1040 – MASONRY UNITS

1040.01 Clay or Shale Brick.

A. Meet the following Specifications and grade requirements:

1. *Sewer Brick.* Meet Owner's requirements.

2. *Building Brick*. Provide solid building brick meeting ASTM C 62, Grade SW or architectural brick meeting ASTM C 216. Brick must be new, whole brick of the best quality, uniform and dense structure, and free of lumps from lime, laminations, cracks, checks, soluble salt, or other defects that may impair the strength, durability, appearance or usefulness for the purpose intended.

3. *Pedestrian.* For pedestrian brick, meet ASTM C 902, class SX, type 1.

4. *Vehicular Paving Brick*. For vehicular paving brick, meet ASTM C 1272.

1040.02 Concrete Brick.

A. For concrete brick, meet ASTM C 55 for the grade specified.

1040.03 Concrete Masonry Blocks.

A. For concrete masonry blocks, use rectangular or segmented concrete masonry blocks and, when specified, shape ends to interlock at vertical joints. Use solid blocks meeting requirements of ASTM C 139 or C 90, except that a maximum absorption value of 18 pounds per cubic foot for lightweight units, 15 pounds per cubic foot for medium weight units, and 13 pounds per cubic foot for normal weight units is acceptable. A minimum compressive strength of 2000 pounds per square inch is permitted for units less than 5 inches in thickness. Use hollow blocks meeting ASTM C 90. Comply with the dimensions specified.

1040.04 Stone Masonry.

A. *Rubble Stone*. For stone masonry with rubble stone, provide unweathered stone without worn, rounded, or weathered faces.

B. *Ashlar Stone*. For stone masonry with ashlar stone, provide stone that is reasonably fine grained and uniform in color and free of defects. Ensure that the stone is of demonstrated satisfactory quality and of such character that it can be brought to plane or curved lines and surfaces.

1040.05 Dimensional Stone.

A. *Limestone dimensional stone*. For limestone dimensional stone, meet ASTM C 568.

B. *Granite dimensional stone*. For granite dimensional stone, meet ASTM C 615.

C. *Quartz based dimensional stone*. For quartz based dimensional stone, meet ASTM C 616.

D. *Slate dimensional stone*. For slate dimensional stone, meet ASTM C 629.

SECTION 1041 - WOOD

1041.01 Definitions.

A. *Lumber* – The product of the saw and planing mill for which manufacturing is limited to sawing, resawing, passing lengthwise through a standard planing machine, crosscutting to length, and matching. Lumber may be made from either softwood or hardwood.

B. *Timber* – Lumber that is nominal 5 inches or more in the least dimension.

C. *Rough Sawn* – Lumber or timber that has not been dressed (surfaced) but has been sawn, edged and trimmed.

D. *Dressed* – Lumber or timber that has been planed (surfaced).

1041.02 Sawn Wood.

A. Manufacture sawn wood products, meeting AASHTO M 168, of the species, grade, and finish (rough sawn or dressed) specified on the Plans. If none is specified, provide long leaf or short leaf southern yellow pine or close-grained Douglas fir, No. 1 grade or better, cut square and surfaced on four sides.

1041.03 Structural Glued, Laminated Timber.

A. Manufacture structural glued laminated timber of the sizes, shapes and engineering properties indicated on the Plans, according to AASHTO M 168. If the wood species is not specified, use kiln-dried Douglas fir or southern pine.

B. As employed in AASHTO M 168, structural glued laminated timber is an engineered product of a timber-laminating plant. The product consists of suitably selected and prepared wood laminations securely bonded together with wet use adhesives. Ensure that the grain of all laminations is approximately parallel longitudinally and that the maximum net thickness for the separate laminations is 2 inches. Laminations may consist of pieces end joined to form any length, pieces placed or glued edge-to-edge to make wider pieces, or pieces bent to a curved form during gluing.

1041.04 Wood Treatment.

A. *Preservatives.* Treat wood with a preservative suitable to the conditions of exposure in compliance with US Environmental Protection Agency pesticide registration requirements, and in accordance with AASHTO M 133 or American Wood Protection Association (AWPA) Standards, U1 and T1, and the following limitations. Do not use the preservatives interchangeably.

1. When treatment is completed, clean off excess preservative from the wood surface.
2. Use a waterborne preservative where a clean surface is desirable or the timber is to be painted.
3. Use preservatives that conform to the requirements of AWPA.
4. Treat wood used for highway construction and maintenance applications for sign posts, fence posts, wood posts, guardrail posts, bridge decking, gates, stair treads, and offset blocks with preservatives specified in AASHTO M 133 or in accordance with AWPA Standard U1: Commodity Specifications A (Sawn Products) or B (Posts).
5. Treat wood used for highway construction and maintenance applications for piles, timbers, and composites with preservatives specified in AASHTO M133 or in accordance with AWPA Standard U1: Commodity Specifications A (Sawn Products), E (Piles) and F (Wood Composites).
6. Treat with either alkaline copper quarternary (ACQ) salt or copper azole (CA) preservative wood that is used for hand-contact surfaces such as handrails, playground equipment, and picnic tables. With any wood preservative chemistry, always use fasteners or connectors that are either 304 or 316 stainless steel or hot-dipped galvanized in accordance with the requirements of ASTM A 153 or ASTM A 653, Class G 185. Do not use mechanically galvanized steel.

7. Treat according to the following practices:

   a. Perform the preservation treatment process in conformance to the applicable requirements of AWPA Standard T1 and the applicable use and commodity specifications.

   b. Treat glulam timber according to AWPA Standard U1: Commodity Specification F (Wood Composites). Mechanically incise douglas fir in accordance with the lumber industry accepted practice before preservative treatment. Once treated, do not paint nor allow the surface of the member to come into contact with human or animal skin.

B. *Branding and Job Site Inspection*. Identify each piece of treated timber with a legible brand, mark, or tag to identify the treater and the specification requirements to which the treatment conforms. The Engineer will allow treated wood products bearing the quality mark of the AWPA. The Engineer may require the treated timber to be reinspected at the job site to determine retention of preservatives and may extract and analyze the preservative to determine its quality.

C. *Inspection at Treatment Plant.* Ensure inspections are performed at the plant according to AASHTO M 133 or AWPA Standards. The treater or an independent commercial inspection agency approved by the ALSC and the Engineer, may perform these inspections. The Contractor may engage the inspection agency either directly or through the supplier.

D. *Certificate of Compliance*. Ensure that a manufacturer's certificate of compliance and inspection reports accompany each shipment. Identify the preservative used, the specification required, and the test results. Ensure documents are signed by the treater or the qualified independent inspection agency.

E. *Field Treating*. Field treat all cuts, drilled holes, recesses and abrasions that occur after treating timbers or lumber products according to the requirements of the American Wood Protection Association Standard M4, "Standard for the Care of Preservative Treated Wood Products."

1041.05 Wood Connectors and Hardware.

A. Connectors. Meet Section 1039.02.

B. Rods, Plates, Eyebars, and Shapes. Meet Section 1039.

C. Cast Steel or Gray Iron Castings. Meet Section 1039.07.

D. Hardware. Provide machine bolts, drift pins, dowels, nuts, washers, lag screws, and nails that conform to the requirements of ASTM A307. Provide machine bolts with square heads and nuts, unless otherwise specified. Provide nails that are cut or round wire of standard form. Provide spikes that are cut or wire spikes, or boat spikes, as specified. Ensure that nails, spikes, bolts, dowels, washers, rods, plates, and lag screws are completely galvanized according to the requirements of AASHTO M 232. For glulam timber, provide all steel connections and all hardware for joining wood members to each other and to the substructure. Ensure that all hardware is galvanized mild steel AASHTO M 270. Provide washers that are hot-dipped galvanized steel, cast iron or malleable iron. Provide fasteners or connectors that will be in contact with wood treated with ACQ or CA wood preservative treatments made of either 304 or 316 stainless steel or hot-dipped galvanized steel that conforms to the requirements of AASHTO M232 or ASTM A653, Class G185.

E. Mechanically galvanized steel is prohibited.

1041.06 Certificates of Compliance.

A. Furnish the following certificates of compliance, as applicable, to the Engineer, upon delivery of the Materials to the job site:

   1. Certification by an agency certified by the American Lumber Standards Committee that the timber or lumber conforms to the grade, species, and any other specified requirements.

   2. Certification by a qualified inspection and testing agency that the glued-laminated timber complies with the grade, species, and other requirements outlined in ANSI/AITC A190.1.

3. If the wood is to be treated with a preservative, certification of compliance, as specified in Section 1041.04.D.

SECTION 1042 – JOINT/CRACK SEALANT MATERIAL

1042.01 Material Requirements.

1042.01.1 Asphalt pavements, per Contract Documents:

A. *Crack Sealing*. ASTM D 5078,

B. *Joint Sealing*. ASTM D 6690 Type II

1042.01.2 Portland Cement Concrete pavements, per Contract Documents:

A. *Joint Sealing.* ASTM D 6690 Type II

B. *Preformed Elastomeric Compression Joint Seals.* ASTM D 2628

C. *Preformed Expansion Joint Material.* AASHTO M 153, Type IV, Polyurethane bonded recycled rubber.

1042.01.3 Portland Cement Concrete Structures, per Contract Documents:

A. *Preformed Elastomeric Compression Joint Seals.* ASTM D 2628.

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 ASTM C 920. The color shall be gray to match the concrete.

C. *Joint Sealing.* ASTM D 6690 Type II or cold applied elastomeric sealant conforming to ASTM C 920.

D. *Preformed Expansion Joint Material.* AASHTO M 153, Type IV, Polyurethane bonded recycled rubber.

1042.01.4 Strip Seal Material.

A. Furnish elastomeric Material that is extruded 100 percent virgin Polychlorprene (Neoprene) in accordance with ASTM D2628 with the recovery test omitted. The elastomeric Material shall also meet the following:

ASTM STANDARD	PHYSICAL PROPERTIES	PERFORMANCE REQUIREMENTS
D2240 (Modified)	Hardness	60±7 points, Durometer Type A
D412	Tensile Strength	2000 psi minimum
D412	Ultimate Elongation	250% minimum
D395 (Method B)	Compressive Set (70 hours at 212^0F)	40% maximum
D573	Compressive Set (212^0F)	40% maximum
D1630	Abrasion Resistance	Index of 200 or greater
D1149	Oxone Resistance 20% strain 300 pphm in air, 70h @ 140F (wiped with tolune to remove surface contamination)	No cracks
D471	Oil Swell – ASTM Oil #3, 70 hours at 212 ^{0}F, weight change	45% maximum
D2240	Low Temperature Stiffening – maximum 7 days at 14^0F	+15 points, Durometer Type A

1042.01.5 Asphaltic Plug Joint Materials.

A. Furnish steel closure plate in accordance with AASHTO M270, Grade 36 with the following dimensions: 0.25 inch thick, 8 inches wide, 4 feet long, and perforated with 0.25 inch diameter holes along the centerline spaced at 1 foot maximum intervals.

B. Furnish binder Material that is modified elastomeric and in accordance with ASTM D6690 and AASHTO M324 Type I. Binder Material shall also meet the following requirements:

ASTM STANDARD	PHYSICAL PROPERTIES	PERFORMANCE REQUIREMENTS
E28	Softening Point	83^0C minimum
D3407	Flow at 60^0C	3 mm maximum
D5329	Penetration	90 maximum at 25^0C
D5329	Resilience	40-70
D113	Ductility at 25^0C	40 cm minimum
D5329	Bond at -29^0C, 50%	Pass 3 cycles
D5329	Bond at -18^0C, 50%	Pass 3 cycles
D5329	Tensile Adhesion	700% minimum

C. Furnish aggregate Material consisting of Granite, Basalt, Gabbro, Porphyry, or Griststones. Double wash and double crush aggregate to ensure angular and cubic formations such that less than 20 percent have a minimum dimension or thickness less than 0.6 of the mean of the normal size. Aggregate shall meet the following gradation requirements:

Sieve Size	Percent Passing
1”	100
¾”	85-100
½”	45-75
3/8”	20-45
¼”	0-20
Washed #200	<1

D. Furnish backer rod consisting of closed cell foam capable of withstanding the temperature of the hot binder and sized per manufacturer's recommendations. Backer rod Material shall also meet the following requirements:

Density	2 psf minimum
Tensile Strength	30 psi minimum
Compression	5 psi minimum at 25%
Water Absorption	0.03 g/cc minimum by weight
Temperature at 210^0C	No melting
Locating Pin	Galvanized 16D Common Nail (ASTM A153)

E. Furnish parapet joint seal that is either a two component viscous blend that can be used on vertical or near vertical faces or a self-leveling seal for use in sidewalks. The Material must be able to bond to both the asphaltic joint seal Material and concrete to create a watertight system. The Material shall also meet the following requirements:

ASTM STANDARD	**PHYSICAL PROPERTIES**	**PERFORMANCE REQUIREMENTS**
ASTM D5329	Flow (@93°C) 5 hrs.	0
ASTM D5329	Penetration @25°C, 150g, 5 sec.	80 dmm max.
ASTM D5329	Penetration @-18°C, 200g, 60 sec.	18 dmm max.
ASTM D5329	Resilience @25°C	85% min.
ASTM D5329	Bond @-20°C, 100%, non-immersed	Pass 3 cycles
ASTM D5329	Bond @-20°C, 100%, water immersed	Pass 3 cycles
ASTM D412	Tensile Adhesion	800% min.

SECTION 1043 – JOINT BACKUP MATERIAL

1043.01 Material Requirements.

Use joint sealing backup Material of a stitched cotton piping cord, polyethylene backer rod, or approved equal Material that is compatible with the sealant to be used and capable of withstanding the required sealant application temperature without melting.

Stitched Cotton Piping Cord	ASTM D 5249
Backer Rod	ASTM D 5249

Provide back-up Material, prior to installation, at least 25 percent wider than the nominal width of the joints. Size the diameter of the backup material/bond breaker so that when placed in the joint it will support the sealant at its design depth, allowing the sealant to achieve the design shape, prevent the sealant from leaking around and underneath it, and allow the sealant to deform freely when the joint expands and contracts.

SECTION 1044 – ALUMINUM FOR STRUCTURES

1044.01 Aluminum Materials.

A. *General*. Furnish aluminum as specified in the Plans. Ensure that the supplier provides a lot number on the shipping package and a certification. Fabricate structural aluminum in accordance with the *AASHTO LRFD Bridge Construction Specifications* and the *AWS D1.2 Structural Welding Code—Aluminum*.

B. *Aluminum Plate / Sheet*. Meet ASTM B 209.

C. *Aluminum Extrusions*. Meet ASTM B 221, B 308, or B 429M.

1044.02 Fasteners.

A. *Aluminum Rivets*. Meet ASTM B 316.

B. *Dimensions*. Ensure bolt and nut dimensions meet the Heavy Hexagon Structural Bolts and Heavy Semi Finished Hexagon Nuts requirements in ANSI B18.2.1 and B18.2.2, respectively.

C. *Galvanizing*. Ensure high-strength steel fasteners are either hot dip galvanized according to AASHTO M 232, Class C, or mechanically galvanized according to ASTM B695, Class 50. Use the same process to galvanize washers, nuts, and bolts of any assembly.

D. *Aluminum, Stainless Steel, and Steel Lock-Pin and Collar Fasteners*. Meet Military Specification MIL-P-23469.

1044.03 Welding Requirements.

A. Meet AASHTO / AWS D1.2 *Structural Welding Code—Aluminum*.

1044.04 Aluminum Forgings.

A. Meet ASTM B 247.

1044.05 Castings.

A. *Aluminum Castings*. Meet ASTM B 26.

B. *Aluminum-Alloy Permanent Mold Castings*. Meet ASTM B 108.

SECTION 1045 – CONCRETE COATINGS AND MEMBRANES

1045.01 Epoxy Coating.

A. Furnish a high solids epoxy coating that complies with all VOC regulations.

B. Additional requirements are as follows:

Minimum Solids Content	72% by Weight
Tensile Strength (ASTM D 638)	>1400 psi
Shelf Life	Minimum 12 months
Working Life	Minimum 1 hour
Sag Resistance	20 mils
Moisture Permeability (ASTM E 96)	0.16 perms

C. The color must be Insignia White (Federal Color FS 37925 of FED-STD-595C) unless specified otherwise on the Plans.

1045.02 Silicone-Based Acrylic Coating.

A. Furnish a sealer that consists of methyl methacrylate-ethyl acrylate copolymer resins and toning pigments suspended in solution of all times by a chemical suspension agent and solvent. Laminar silicates, titanium dioxides, and inorganic oxides may be used for toning pigments. Use of vegetable or marine oils, paraffin materials, stearates or organic pigments in the formulation will not be permitted.

B. Furnish a sealer that is an opaque, non-film forming, and penetrating silicone acrylic compound. The sealer must pass NCHRP 244 Series II, salt spray resistance requirements and be local OTC-VOC compliant.

C. The color must be Insignia White (Federal Color FS 37925 of FED-STD-595C) unless specified otherwise on the Plans.

1045.03 Silane Sealer.

A. Furnish a sealer that consists of a one component clear, deep penetrating Isobutyl alkoxysilane sealer. The sealer cannot alter the color or texture of Portland cement concrete. The product used must be a 40 percent minimum silane solution by weight diluted in a suitable alcohol based solvent. No petroleum distillates are permitted. The Materials must be local OTC-VOC compliant.

B. The water proofing Material must be a flowable, penetrating solution capable of being applied by spray or roller. The applied and cured Materials must not form a film or otherwise build up on the surface of the treated surface.

C. The Materials must pass a chloride screen test using NCHRP 244 Series IV (1 application at 125 square feet per gallon) min 90 percent.

D. Tint the waterproofing Material with a fugitive red or other dye to enable the silane solution to be visible on the concrete surface for at least four hours after application. The fugitive dye must not, however, be visible more than seven days after the application of the waterproofing Material.

1045.04 High Molecular Weight Methacrylate Sealer.

A. Furnish a sealer that consists of a wax-free low odor, high molecular weight methacrylate prime coat. Use a prime coat, resin that has a maximum volatile content of 30 percent when tested in accordance with ASTM D 2369 prior to adding initiator. The resin must also conform to following:

High Molecular Weight Methacrylate (HMWM) Resin		
Property	**Requirement**	**Test Method**
Viscosity* (Brookfield RVT with UL adapter, 50 RPM at 77ºF)	0.025 Pa·s, maximum	ASTM D 2196
Specific Gravity* (at 77ºF)	0.90, minimum	ASTM D 1475
Flash Point* (Degrees C)	10	ASTM D 3278
Vapor Pressure* (mm Hg at 77ºF)	1.0	ASTM D 323
Tack Free Time (minutes at 77ºF)	400 min. maximum	ASTM C 679
PCC Saturated Surface-Dry Bond Strength (MPa at 24 hrs at 70±1ºF)	0.5 psi minimum	

*Tested prior to adding initiator

B. Use a prime coat promoter/initiator that consists of a metal drier and peroxide. If supplied separately from the resin, **at no time mix the metal drier directly with the peroxide.** Store the containers in a manner that will not allow leakage or spillage from one Material to contact the containers or Material of the other.

NOTE: Mixing the metal drier directly with the peroxide will result in a violent exothermic reaction.

C. Submit samples of the Materials to the Materials and Research Section at least sixty (60) Days prior to the application. Ship all components in strong, substantial containers that bear the manufacturer's label specifying the date of manufacture, batch number, brand name, quantity, and date of expiration or shelf life. In addition, provide the mixing ratio printed on the label of at least one of the system components. If bulk resin is to be used, notify the Engineer in writing 10 Days prior to the delivery of the bulk resin to the job site. Bulk resin is any resin that is stored in containers in excess of 55 gallons.

1045.05 Membranes.

A. Furnish a waterproofing asphaltic membrane consisting of a woven or non-woven, needle punched composite membrane with a minimum thickness of 60 mils. Woven fiberglass reinforcement or non-woven, needle punched polypropylene shall be sandwiched between rubberized asphalt compound or adhesive membrane. The Materials must have sufficient adhesive property or be applied with primer tack coat. The primer/tack adhesive Materials must be compatible with the asphaltic membrane and used as per recommendation of the manufacturers.

B. Additional requirements for traffic bearing membranes are as follows:

Property	**Test Method**	**Standard**
Strip Tensile	ASTM D 882	50 lb/in min
Puncture Resistance	ASTM E 154	200 lbs min
Permeance	ASTM E 96 Method B	0.10 perms (max)
Pliability	ASTM D 146	No crack or split
Elongation	ASTM D 882	50% minimum

C. Additional requirements for membranes not in traffic bearing situations are as follows:

Property	**Test Method**	**Standard**
Strip Tensile	ASTM D 882	50 lbs/in min
Puncture Resistance	ASTM E 154	40 lbs min
Permeance	ASTM E 96 Method B	0.05 perms (max)
Pliability	ASTM D 146	No crack or split

SECTION 1046 – CONCRETE OVERLAY MATERIALS

1046.01 Latex Modified Concrete.

1046.01.1 Materials.

A. Furnish Portland cement conforming to Section 1020.

B. Furnish fine aggregates in accordance with Section 1022.

C. Furnish coarse aggregate conforming to Section 1022. The coarse aggregate grading must conform to the requirements of Section 1004, Delaware Number 8.

D. Store coarse and fine aggregate in accordance to Section 1022.

E. Furnish water conforming to the requirements of Section 1021.

F. Furnish latex modifier for concrete that is non-toxic, film forming, polymeric emulsion to which all stabilizers have been added at the point of manufacture. Latex modifier must be homogeneous and uniform in composition.

1046.01.2 Mix Design.

A. Submit the Materials for the Project to the Engineer for approval. Once approved, design the actual batch weights based on tests in accordance with the limits shown in Table 1046-1 below. Submit the design to the Engineer for approval. State the proportions in terms of aggregates in a saturated surface-dry condition. Be sure to adjust the batch weights periodically to take into account the actual moisture of the aggregates at the time of use.

B. Do not change the proportions and the slump, nor the source or character of the Material, for the approved latex concrete during the progress of the Work. Submit any changes to the Engineer for approval prior to continuing the Work.

C. Establish a design mix for the latex concrete that meets the requirements noted below in Table 1046-1:

Table 1046-1

Property	**Latex Modified Concrete Mix**
Formulated Latex - gallons/sack of cement	3.50
Percent of Fine Aggregate as percent of Total Aggregate by weight	50 - 60
* Weight ratio of cement: fine aggregate: Coarse aggregate dry basis (aggregate Specific Gravity = 2.65)	1.0:2.5:2.0
Air Content - Maximum Percent of Plastic Mix (there is no minimum)	6.5%
** Slump (inches)	4 - 6
Water - cement ratio	0.40 Max.
Minimum compressive strength @ 28 days	4000 psi
*The dry weight ratios are approximate and should produce good workability but due to gradation changes may be adjusted within limits. The fine aggregate ratio may be increased by as much as 0.2 if the coarse aggregate is reduced by an equivalent volume.	
**The slump will be measured 4 to 5 minutes after discharge from the mixer. During this waiting period, do not disturb the mix.	

D. Chloride permeability must be no greater than 1000 coulombs based on a 28 day cure by AASHTO T385, Note 3. The permeability test samples will be field-cast cylindrical specimens with a 4 inch diameter and at least 4 inch in length. They will be air cured at a temperature of 73 ± 3 degrees Fahrenheit for one week and the last three weeks of the air cure will be at 100 ± 9 degrees Fahrenheit. Cylinders will be tested at 28 days in accordance with the AASHTO T 277 Test Method.

1046.02 Micro-silica Modified Concrete.

1046.02.1 Materials.

A. Furnish Portland cement conforming to Section 1020.

B. Furnish fine aggregates in accordance with Section 1022.

C. Furnish coarse aggregate conforming to Section 1022. The coarse aggregate grading must conform to the requirements of Section 1004, Delaware Number 8.

D. Store coarse and fine aggregate in accordance to Section 1022.

E. Furnish water conforming to the requirements of Section 1021.

F. Furnish micro-silica (silica fume) conforming to AASHTO M 307.

G. Furnish air entraining agents conforming to AASHTO M 154.

H. Furnish high range water reducers conforming to ASTM C 494.

I. Furnish fiber reinforcement conforming to ASTM C 1116, Type III with a minimum fiber length of ½ inch and a maximum length of 1-1/2 inch.

J. Furnish an evaporative retardant specifically marketed for the use of retarding evaporation from a concrete surface; plain water is not acceptable.

1046.02.2 Mix Design.

A. Submit the Materials for the Project to the Engineer for approval. Once approved, design the actual batch weights based on tests in accordance with the limits shown in Table 1046-2 below. Submit the design to the Engineer for approval. State the proportions in terms of aggregates in a saturated surface-dry condition. Be sure to adjust the batch weights periodically to take into account the actual moisture of the aggregates at the time of use.

B. Do not change the proportions and the slump, nor the source or character of the Material, for the approved latex concrete during the progress of the Work. Submit any changes to the Engineer for approval prior to continuing the Work.

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C. Establish a design mix for the micro-silica modified concrete that meets the requirements noted below in Table 1046-2:

Table 1046-2

Property	**Micro-Silica Modified Concrete Mix**
Water/(Cement & Micro-silica) Ratio	0.40 Max.
*Micro-silica content (Percent of weight of Portland cement)	7%
Slump (inches)	4 - 6
Air Content	4-7%
Fiber Reinforcement Content	1.5 lb/yd^3
Minimum compressive strength @ 28 days	4000 psi
*Obtain a written statement from the manufacturer of the micro-silica that it is compatible with the other materials from the sources proposed and acceptable in the sequence in which they will be combined.	

D. Chloride permeability must be no greater than 1000 coulombs based on a 28 day cure by AASHTO T385 Note 3. The permeability test samples will be field-cast cylindrical specimens with a 4 inch diameter and at least 4 inch in length. They will be air cured at a temperature of 73 ± 3 degrees Fahrenheit for one week and the last three weeks of the air cure will be at 100 ± 9 degrees Fahrenheit. Cylinders will be tested at 28 days in accordance with the AASHTO T 277 Test Method.

SECTION 1047 – GROUT AND FLOWABLE FILL

1047.01 Flowable Fill.

1047.01.1 Materials

A. Provide Materials as specified in:

Portland Cement	Section 1020
Fine Aggregate	Section 1022
Air-Entraining Admixtures	AASHTO M 154
Chemical Admixtures	AASHTO M 194
Fly Ash	Section 1020
Ground Granulated Blast Furnace Slag (GGBFS)	Section 1020
Water	Section 1021

B. Submit Material test data of fly ash representative of the source to the Engineer a minimum of 30 Days prior to use. Include test data characteristics of the ash leachate as determined by the Toxicity Characteristics Leaching Procedure (TCLP) in accordance with EPA SW-846, with respect to leachate metals.

1047.01.2 Mix Design. Prepare and submit a mix design a minimum of 30 Days in advance of use.

A. Design the Material to produce a 28-day compressive strength of 50 to 200 pounds per square inch.

B. Test compressive strength in accordance to procedures AASHTO T106M/T

Provide flowable fill produced only in batching plants meeting the requirements of Section 1022.06.2.

1047.02 Non-Shrink Grout

Grout for general purpose use must meet ASTM C1107 grade C.

1047.03 Access Tubes

Grout for filling the access tubes at the completion of the crosshole sonic log tests must be a neat cement grout with a minimum water/cement ratio of 0.45. The minimum compressive strength of the grout must match or exceed the specified minimum design compressive strength of the drilled shaft as noted in the Contract Documents.

SECTION 1048 – MECHANICALLY STABILIZED EARTH WALL MATERIALS

1048.01 Material Requirements.

A. Provide backfill in accordance with the following:

1. Provide backfill Material that is reasonably free from organic and deleterious Materials. Do not use metallurgical slag.

2. Stone shall meet the requirements for #57 stone in accordance with Section 1004.

3. Soil shall meet the following requirements:

a. Magnesium sulfate soundness loss of less than 30 percent after 4 cycles as determined by AASHTO T104.

b. Plasticity Index (P.I.) of less than 6 as determined by AASHTO T 90.

c. Fraction finer than 15 microns of less than 10 percent as determined by AASHTO T 88.

d. Angle of internal friction of not less than 34 degrees as determined by the standard direct shear test in accordance with AASHTO T 236. Material to be included shall be the portion finer than the #10 sieve and compacted to 95 percent of AASHTO T 99, method C or D (with oversize correction, as outlined in Note 7, AASHTO T 99) at optimum moisture content.

e. Electrochemical properties in accordance with the following:

Property	**Value**
pH	5 to 10
Resistivity (min)*	3000 ohm-cm
Chloride Content (Max)	100 ppm
Sulphate Content (Max)	200 ppm
Organic Content (Max)	1%

*If the Resistivity is greater than 5000 ohm-cm, the chloride and sulfate requirements may be waived by the Engineer.

f. Gradation requirements in accordance with AASHTO T27 as outlined below:

Sieve Size	**Percent Passing**
3 inches (75 mm)	100%
¾ inch (18 mm)	20% to 100%
No. 40 (425 µm)	0% to 60%
No. 200 (75 µm)	0% to 10%

g. The frequency of sampling of select granular backfill necessary to assure gradation control throughout construction shall be as directed by the Engineer.

B. Provide concrete in accordance with Section 610 and Section 1022. Unless noted otherwise, concrete shall meet the following:

   a. Leveling Pad – Class B (3000 pounds per square inch)

   b. Wall Panels – Class A (5000 pounds per square inch)

   c. Coping – Class A (4500 pounds per square inch)

C. Provide reinforcing mesh in accordance with AASHTO M55. Provide galvanization for the mesh in accordance with ASTM A123.

D. Provide bar reinforcement in accordance with Section 611 and 1037.

E. Provide embed loop and connector bar as follows:

   1. Fabricated of cold drawn steel wire meeting the requirements of ASTM A1064.

   2. Welded in accordance with ASTM A1064.

   3. Galvanized in accordance with ASTM A123.

F. Provide geotextile filter fabric and adhesive for covering the rear side of the horizontal and vertical/inclined joints that is approved by the Engineer.

G. Provide polyethylene pads to be used in the horizontal joints between facing panels with a minimum density of 0.946 g/cm^3 in accordance with ASTM D1505.

H. Provide alignment pin that is 5/8 inch min. diameter, mild steel, round, and smooth and is galvanized to meet the requirements of ASTM A123.

I. Provide tie strip that is shop fabricated of hot rolled steel in accordance with ASTM A1011, Grade 50. Provide galvanization in accordance with ASTM A123.

J. Provide reinforcing strip that is hot rolled from bars to the required shape with dimensions and physical and mechanical properties in accordance with ASTM A572, Grade 65. Provide galvanization in accordance with ASTM A123.

K. Provide mechanically galvanized bolts and nuts in accordance with Section 1039.

L. Provide cast-in-place concrete in accordance with Section 610 and Section 1022. Unless noted otherwise, concrete shall meet the following:

   1. Leveling Pad – Class B (3000 pounds per square inch)

   2. Coping – Class A (4500 pounds per square inch)

M. Provide precast concrete wall panels in accordance with the following:

   1. Testing & Inspection - All precast units are acceptable when compression test results indicate strength will meet 28 day specifications. Panels utilizing Type I or II cement will be considered acceptable for placement in the wall when 7 day initial strengths exceed 8 percent of the 28 day requirements. Panels utilizing Type III cement will be considered acceptable for placement in the wall prior to 28 days only when compressive strength test results indicate that the strength meets the 28 day specification.

   2. Casting – Cast the panels on a flat area with the front face of the panel at the bottom and the back face at the upper part. Set coil loop inserts, rebar, PVC pipe and lifting devices in place to the dimensions and tolerances shown on the drawings prior to casting. Place the PVC pipe in a manner as to insure that it is not bent or bowed. Set coil loop inserts on the rear face. Place the concrete in each unit without interruption and consolidate by the use of an approved vibrator, supplemented by hand tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of aggregate pockets, air bubbles or cleavage planes. Use clear form oil of the same manufacturer throughout the casting operation.

   3. Attach all coil loop inserts to the alignment templates using the bolts provided with the forms. Place

the vertical and horizontal alignment of the coil loop inserts, free of all concrete or debris, loose or otherwise, 2-1/4 inch deep in the finished panel. Ensure that no concrete or other debris is on the interior surfaces of the coils of the coil loop inserts in the finished panels. Immediately after the alignment template is removed, place duct tape over the coil loop insert holes in order to prevent debris from entering the holes. Removal of the duct tape is only permitted by the crew that is assembling the wall. Take care to insure that the duct tape is not removed during shipping.

4. Curing – Cure the units for at least 72 hours. Any panel which does not reach specified strength within 28 days will be rejected.

5. Removal of forms – Do not remove the forms until they can be removed without damage to the unit.

6. Concrete Finish:

   a. Front - As specified on Plans

   b. Rear - Unformed surface, roughly screeded to eliminate open pockets of aggregate and surface distortions in excess of 1/4 inch.

7. Tolerances:

   a. Panel dimensions – within 3/16 inch except that the lateral position of tie strips within 1 inch.

   b. Panel squareness – within 1/2 inch as determined by the difference between the two diagonals.

   c. Panel surface defects:

      i. Smooth formed surfaces – not to exceed 1/8 inch per 5 foot length.

      ii. Textured finished surfaces – not to exceed 5/16 inch per 5 foot length.

8. Compressive strength - Acceptance of the concrete panels with respect to compressive strength will be determined on a basis of production lots. A production lot is defined as a group of panels representing 40 panels or a single day's production, whichever is less.

   a. During the production of the concrete panels, randomly sample the concrete in accordance with AASHTO R 60. A single compressive strength sample consists of a minimum of 4 cylinders randomly selected for every production lot. Prepare 6 inch x 12 inch cylinders for compressive strength tests and test in accordance with AASHTO T 23 and T 22, respectively. For every compressive strength sample, cure a minimum of 2 cylinders in the same manner as the panels and test at approximately 7 days. The average compressive strength of these cylinders, will determine the initial strength of the concrete. In addition, cure 2 cylinders in accordance with AASHTO T 23 and test at 28 days. The average compressive strength of these two cylinders, will determine the compressive strength of the production lot.

   b. If the initial strength test results indicate a compressive strength in excess of 4500 pounds per square inch, then these test results will be utilized as the compressive strength test results for that production lot and the requirement for testing at 28 days will be waived for that particular production lot.

   c. Acceptance of a production lot will be made if the compressive strength test result is greater than or equal to 4500 pounds per square inch. If the compressive strength test result is less than 4500 pounds per square inch, the acceptance of the production lot will be based on its meeting the following acceptance criteria in its entirety:

      i. Ninety (90) percent of the compressive strength test results for the overall production exceeds 4,670 pounds per square inch.

      ii. The average of any six (6) consecutive compressive strength test results exceeds 4,750 pounds per square inch.

      iii. No individual compressive strength test result falls below 4,050 pounds per square inch.

   d. If a production lot fails to meet the specified compressive strength requirements, the production lot

will be rejected. The rejection prevails unless the manufacturer, at his own expense, obtains and submits evidence of a type acceptable to the Engineer that the strength and quality of the concrete placed within the panels of the production lot are acceptable. If the evidence consists of tests made on cores taken from the panels within the production lot, obtain and test the cores in accordance with the requirements of AASHTO T 24.

9. Rejection – Units are subject to rejection because of failure to meet any of the requirements specified above. In addition, any or all of the following defects may be sufficient cause for rejection:
   a. Defects that indicate imperfect molding.
   b. Defects that indicate honeycombed or open texture concrete.
   c. Defects in the physical characteristics of the concrete, such as broken or chipped concrete.
   d. Stained form face, due to excessive form oil or others.
   e. Signs of aggregate segregation.
   f. Broken or cracked corners.
   g. Tie strips bent or damaged.
   h. Lifting inserts not usable.
   i. Exposed reinforcing steel.
   j. Cracks at the PVC pipe or pin.
   k. Panel thickness varying in excess of $\pm$ 3/16 inch from that shown on the Plans.
10. Marking – Clearly scribe or paint with waterproof paint on the rear face of each panel the date of manufacture, the production lot number, and the piece-mark.
11. Handling, Storage & Shipping – Handle, store and ship in a manner as to eliminate the danger of chipping, discoloration, cracks, fractures and excessive bending stresses. Support panels in storage on firm blocking to protect the exposed exterior finish.
12. Joints – Provide geotextile fabric sheets with a minimum width as follows:
    a. Vertical/Inclined Joints – 18 inch
    b. Horizontal Joints – 18 inch
    c. Laps in Fabric – 4 inch

SECTION 1049 – MISCELLANEOUS ITEMS FOR CONCRETE WORK

1049.01 Pipe for Weep Holes.

A. Cast iron pipe for weep holes in conformance with ASTM A 74.

B. Plastic pipe for weep holes in conformance with ASTM D 2665.

1049.02 Form Oil for Concrete Formwork.

Use form oil that is a non-staining petroleum distillate free from water, asphaltic, and other insoluble residue or equivalent product.

1049.03 Waterstops.

Provide water stops that are polyvinyl chloride (PVC) compounded as necessary to conform to the requirements of U.S. Army Corps of Engineers Specification CRD-C 572. No reclaimed PVC from any sources are permitted for incorporation into the compounding. Use an extruded Material that is dense, homogeneous, and free from porosity or other imperfections that could affect its durability or performance.

SECTION 1060 – GEOTEXTILE

1060.01 Materials Furnish Materials 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 in accordance with the Contract Documents and as specified herein:

A. *Silt Fence* and *Reinforced Silt Fence.* AASHTO M 288 Table 6.

B. *Inlet Sediment Control, Riser Pipe Assembly for Sediment Trap, Sump Pit, Portable Sediment Tank, Sediment Basin Outlet Structure (Corrugated Metal).* AASHTO M 288, Table 5, Class 1 or 2.

C. *Riprap Ditch, Perimeter Dike/Swale, Earth Dike, Temporary Slope Drain, Stilling Well, Geotextile Lined Channel Diversion, Dewatering Basin.* AASHTO M 288, Table 2, Class 2 or 3.

D. *Stabilized Construction Entrance.* AASHTO M 288, Table 1, Class 1, Tables 3 and 4.

E. *Separation Fabric*. AASHTO M 288 Table 1, Class 2, Table 3 and Table 4.

F. *Stabilization Fabric*. AASHTO M 288 Table 1, Class 1 and Table 5.

G. *Underdrain.* AASHTO M 288 Table 1, Class 2 and Table 2.

SECTION 1061 – FENCE

1061.01 Markings.

A. Ensure each roll of fence fabric carries 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. Identify posts, wire, and other fittings 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 herein.

1061.02 Inspection.

A. Each product or Item furnished is subject to inspection at the factory and the fabricating plant, in laboratories of the Department′s choosing, and at all other points of delivery.

1061.03 Chain Link Fence.

A. Chain-link fence must be galvanized steel fabric fence, 9 gage unless specified otherwise. Type 1 Class D coated, knuckled top and bottom or twist top/knuckle bottom conforming to the appropriate requirements of AASHTO M 181.

B. For vinyl-coated chain link fences, meet the following additional requirements:

1. Vinyl coat all chain link fabric, posts, rails, ties, bands, bars, rods and other fittings in accordance with AASHTO M 181 Type IV Class A.

C. For Bridge Safety Fence, meet the requirements specified in 1061.03.A and B and the Standard Construction Details for the respective Item along with the following requirements:

1. Fabric must be #9 gage having a 1 inch diamond mesh with top and bottom selvage to be knuckled. Ensure fabric is continuous across all joints.

2. The fence post and rail must be made of steel pipe in accordance with the requirements of ASTM F 1083.

   a. For fence post, use 2.875 inch O.D. Galvanized post weighting 7.66 pounds per foot.

   b. For fence rail, use 1.66 inch O.D. Galvanized rail weighting 3 pounds per foot.

3. All base plates must be Aluminum Alloy 6061-T6. Coat any aluminum surfaces placed in contact with concrete with a heavy coat of Alkaline Resistant Bituminous Paint equal to Federal Specifications TT-C-498.

4. Material for anchor bolts must be ASTM A 276.

D. Gates

1. Gate frames must be made of steel pipe in accordance with the requirements of ASTM A 53, with an outside diameter of 1.90 inch and a nominal weight of 2.72 pounds per foot.

2. Corners must be heavy malleable iron or pressed steel fittings, securely riveted or welded.

3. Paint the welds with aluminum base or zinc base paint.

1061.04 Right-of-Way Fence.

A. Metal Posts

1. Use tubular steel posts and braces that conform to the requirements of AASHTO M 281 and are galvanized in accordance with AASHTO M 111.

2. Steel posts of tee, channel, wide flange, or U-bar shapes, must be formed structural steel, hot-rolled carbon steel, or hot-rolled rail steel, having a minimum yield strength of 40,000 pounds per square inch and a minimum ultimate strength of 70,000 pounds per square inch. Use steel posts that are 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

1. Use galvanized steel for barbed wire conforming to the requirements of AASHTO M 280 and consisting of two-strand 12-1/2 gage wire with tightly wrapped, sharp, four-point barbs formed of 14 gage wire spaced evenly at not more than 5 inch intervals. Use Type Z, Class 3 for galvanizing.

C. Woven Wire Fencing

1. Woven wire fencing or woven wire fabric must be 9 gage galvanized wire conforming to the requirements of AASHTO M 279, Type Z, Class 3 coating or 9 gage aluminum coated steel wire.

1061.05 Post and Rail Fence.

A. Wood Rail Fences

1. All Materials, such as fence, posts, hardware and accessories used for wood rail fences must be new.
2. Use grade 2 lumber in accordance with Section 1041.02.
3. Treat all lumber in accordance with Section 1041.04 with waterborne preservative.
4. All hardware must conform to Section 1041.05.D.

B. Vinyl Rail Fences

1. Use fence components made of high impact, ultra violet (UV) resistant, rigid poly vinyl chloride (PVC), complying with ASTM D 1784, Class 14244-B, Table 1. Use a minimum wall thickness of 0.135 inch and a minimum corner radius of 3/8 inch for all posts. Use a wall thickness of 0.90 inch and a minimum corner radius of 11/32 inch for all rails. Posts must have one piece, molded caps that have a minimum thickness of 0.095 inch and matches the pool cross section.
2. Incidentals such as fasteners, anchorage and PVC cement must meet the requirements of the manufacturer.

1061.06 Vertical Slat Fence.

A. The timber, including posts, backers and vertical boards, must be southern yellow pine, #2 grade or better and be pressure treated in accordance with Section 1041.04.

B. All hardware, including nails, bolts and fasteners, must be hot dipped galvanized and conform to Section 1041.05.D.

1061.07 Decorative Fence.

A. Aluminum Extrusions: All posts and rails used in the fence system must be made of 6105T5 in accordance with ASTM B 221, or Aluminum alloy having a minimum strength of 35,000 pounds per square inch and pickets have a minimum strength 15,000 pounds per square inch.

B. Fasteners: All screws must be 302 stainless steel self-drilling head. Paint all screws to match the finish of fence. Compatible with fence Material for exterior exposure.

C. Accessories: Use aluminum castings for post caps, brackets, scrolls, finishes and other miscellaneous hardware, with the exception of any Material coming into contact with PCC, in which case galvanized steel shall be used.

D. Pretreatment: Apply a three stage non-chrome pretreatment. The first step is a chemical cleaning, followed by a water rinse. The final stage is a dry-in-place activator which produces a uniform chemical conversion coating for superior adhesion. Plate the screws with zinc dichromate to ensure corrosion resistance.

E. Coating: Fence Materials must be coated as per manufacturer's recommendations. Epoxy powder coatings, baked enamel or acrylic paint finishes are not acceptable. The approved finish must have a cured film thickness of at least 50 µm. In addition, paint the screw heads to match the color of the fence.

F. Tests: The cured approved finish must meet the following requirements:

1. Humidity resistance of 3,000 hours using ASTM D 2247.
2. Salt spray resistance of 3,000 hours using ASTM B 117.
3. Accelerated weathering for 1,000 hours under ASTM D822 showing no adhesion loss, with only a slight fading, chalking and water staining.
4. Minimum hardness of 2H using ASTM D 3363.

G. Use non-shrink grout to fill sleeve. The minimum compressive strength for the grout is 5,000 pounds per square inch at seven days when tested as specified in AASHTO T 106. The non-shrink grout must have a minimum expansion of 0.0 percent after seven days when tested as specified in AASHTO T 160.

H. If the Contractor selects any Material that differs from the Contract Documents or the manufacturer's recommendations, the Material must be pre-approved by the Engineer before installation.

1061.08 Construction Safety Fence.

A. Submit source of supply for all fencing Materials including the posts for approval by the Engineer prior to installation.

B. Construction Safety Fence

1. U.V. stabilized high visibility orange, high density polyethylene.
2. Standard mesh opening size of approximately 1-1/2 inch.

C. Fence Post

1. Oak wood
2. T-Section steel 1.25 inch x 1.00 inch.

SECTION 1062 – CONDUIT

1062.01 Material Requirements. Provide conduit, sweeps, end caps, condulets, conduit hangers, bushings, and all applicable appurtenances of compatible Materials meeting the requirements specified herein.

A. Galvanized Steel Conduit.

1. Hot-dipped galvanized
2. Conform to the requirements of ANSI C80.1, UL-6 and UL-514B.
3. Conform to the National Electric Code 2011, Article 344
4. UL Listed

B. HDPE SDR 13.5 Conduit.

1. Conform to National Electric Code 2011, Article 353
2. For Fiber Optic Conduit, paint in white letters longitudinally, “DelDOT Traffic Fiber Optic Cable”
3. For Lighting Conduit, paint in white letters longitudinally, “DelDOT Lighting Cable”
4. For Traffic Signal Conduit, paint in white letters longitudinally, “DelDOT Traffic Signal Cable”
5. UL Listed

C. Schedule 80 PVC Conduit.

1. Conform to ASTM D2665
2. Conform to National Electric Code 2011, Article 352
3. Conform to ASTM D 1785
4. Conform to U.L. Standard 651 Specifications
5. For Fiber Optic Conduit, paint in white letters longitudinally, “DelDOT Traffic Fiber Optic Cable”
6. For Lighting Conduit, paint in white letters longitudinally, “DelDOT Lighting Cable”
7. For Traffic Signal Conduit, paint in white letters longitudinally, “DelDOT Traffic Signal Cable”
8. UL Listed

D. Flexible Metallic Liquid Tight Conduit.

1. Conform to the National Electric Code 2011, Article 350
2. UL Listed

E. Nonmetallic Pole Riser Shield with belled ends.

1. Rural Utility Service (RUS) listed
2. Conform to NEMA TC-19 specifications
3. Conform to National Electric Code 2011, Article 352

F. Conduit hangers.

1. Steel City Series 6H or 6H-B
2. Grainger Industrial Supply Item # 2000 or 2200
3. Raco/Hubbell, Inc. – Conduit Hangers
4. Approved equal

G. Conduit/duct Sealant.

1. Polywater FST
2. Appleton TMC2x with RapidEx gel
3. Nelson Firestop
4. Approved equal

H. Pulling rope.

1. Polyester or polypropylene with a minimum rated strength of 1,250 pounds.

I. Conduit warning tape.

1. 6-inches wide
2. Minimum thickness of 3 mils
3. 500% elongation
4. Tape identifying fiber optic cable
    a. Color – bright orange (AULCC orange)
    b. Text on label that reads “WARNING – OPTICAL CABLE”
5. Tape identifying all other cables
    a. Color – bright red
    b. Text on label that reads “WARNING – BURIED ELECTRIC BELOW”

SECTION 1070 – GUARDRAIL

1070.01 Materials. Furnish Materials for guardrail, rub rail, structural steel posts, and related hardware in accordance with the Contract Documents and as specified herein:

A. **Steel Posts, Steel Offset Blocks, and Steel Shapes.** ASTM A 769 and hot-dipped galvanized per AASHTO M 111.

B. **Beams.** AASHTO M 180, Class A, Type I or Type II and hot-dipped galvanized per AASHTO M 111.

C. **Hardware.** AASHTO M 180 and zinc coated per AASHTO M 232.

D. **Rods and Turnbuckles**. Minimum tensile strength of 60,000 pounds and hot-dipped galvanized per AASHTO M 111.

E. **Swaged Cable Assembly for Guardrail End Treatment.** ANSI B1.13M, M24 x 3 - 6g with the cable swaged into the fitting.

1. Stud. Meets ASTM A741, Class C or ASTM B695, Class 50.

Machine the hot-rolled ASTM A576, Grade 1035 carbon steel and zinc-coat per AASHTO M 111 before swaging. Anneal suitably for cold swaging. Mill into the stud end a 3/8 inch slot for the locking pin prior to the application of the zinc coating. Drill a lock pin hole through the head of the swaged fitting to accommodate a 1/4 inch plated spring-steel pin to retain the stud in the proper position.

F. **Wire Rope.** AASHTO M 30 and 3/4 inch diameter, 6 by 19 wire stem/core or independent wire rope core (IWRC), zinc-coated, right regular lay wire rope with a minimum breaking strength of 42,000 pounds.

G. **Guardrail Reflectors.** Fabricated from steel sheet plates per ASTM A 6 and galvanized to AASHTO M 232. Retroflectorized sheeting per ASTM D 4956, Type V Abrasive Resistant and applied in accordance with Section 720.03.4.

H. **Timber Post, Blocks and Offset Blocks**. Dimensions per the Standard Construction Details. Timber used for post, blocks and offset blocks per Section 621 and the preservative treatment per Section 1041.04. Composite offset blocks tested and approved under National Cooperative Highway Research Program (NCHRP) Report 350 and Manual for Assessing Safety Hardware (MASH) criteria may also be acceptable provided they hold the rail at the same height and offset as a timber equivalent.

SECTION 1071 – PAVEMENT MARKINGS

1071.01 Latex Paint.

A. Supply white or yellow ready-mixed pigmented binder which is emulsified in water and capable of anchoring reflective glass beads which are separately applied. A paint containing any of the materials listed in the Environmental Protection Agency Code of Regulations (CFR) 40, Section 261.24, Table 1 is not permitted.

B. Supply glass beads that are transparent, clean, colorless glass, smooth and spherically shaped, free from milkiness, pits, or excessive air bubbles and conform to all of the requirements of AASHTO M 247 with the addition of the requirements as noted below.

1. The exceptions to AASHTO M247 are:

   a. All drop on glass beads will have a minimum of 80% truck spheres as measured by ASTM D1155.

   b. All AASHTO Type 1 glass beads will have a moisture proof coating as measured by AASHTO T346.

   c. All AASHTO Type IV glass beads will be treated with an adhesion coating as tested in accordance with the dansyl-chloride test.

2. Submit the following information related to the glass beads:

   a. Submit a 50 pound unopened bag of glass beads to the Materials and Research Section for each lot or batch for testing 30 Days prior to use.

   b. Furnish a copy of the manufacturer's certified analysis of each lot or batch and Material Safety Data Sheet along with each of the samples.

   c. Identify all samples with the Contract number(s) for which the glass beads will be used.

   d. Packaging is as specified in AASHTO M247.

2. Glass bead packaging and marking:

   a. Furnish glass beads in 50 pound, moisture-proof bags. Containers are to be guaranteed to furnish dry and undamaged beads.

   b. Provide the following information on each package:

      i. Name and address of manufacturer

      ii. Shipping point

      iii. Trademark or name

      iv. The wording "glass beads"

      v. Specification number

      vi. Net weight in kg or lbs.

      vii. Lot or batch number

      viii. Month and year of manufacture

C. Meet the following minimum reflectivity values for permanent and temporary latex paint lines:

1. 150 millicandellas for white lines

2. 125 millicandellas for yellow lines

3. Reflectivity readings will be taken with a Delta LTL-X Retroreflectometer with 30 meter geometry, or approved equal.

4. Any lines failing to meet the minimum reflectivity requirements will be required to be re-painted at the Contractor's expense.

1071.02 Epoxy.

A. White and Yellow Reflectorized Epoxy

1. Epoxy Composition Requirements

a. Use an epoxy resin composition specifically formulated for use as a pavement marking Material and for hot-spray application at elevated temperatures. The type and amounts of epoxy resins and curing agents are at the option of the manufacturer, providing the other composition and physical requirements of this Specification are met.

b. Use an epoxy marking Material that is a two-component (Part A and Part B), 100 percent solids type system formulated and designed to provide a simple volumetric mixing ratio (e.g. two volumes of Part A to one volume of Part B).

B. Reflective Glass Spheres/Beads

1. Use reflective glass spheres for drop-on application that conform to the following requirements:

a. Use glass spheres that are colorless, clean, transparent, free from milkiness or excessive air bubbles, and essentially clean from surface scarring or scratching. Use glass beads spherical in shape, having at least 80 percent of the glass beads true spheres when tested in accordance with ASTM D 1155. At least 80 percent of the Type IV beads shall be true spheres as measured by the visual method.

b. The AASHTO M 247 Type 1 glass spheres shall be treated with a moisture-proof coating. They shall show no tendency to absorb moisture in storage and shall remain free of clusters and hard lumps. They shall flow freely from dispensing Equipment at any time when surface and atmosphere conditions are satisfactory for marking operations. The moisture-resistance of the glass spheres shall be determined in accordance with AASHTO T 346

c. Furnish Type IV glass spheres treated with an adhesion coating, that shows no tendency to absorb moisture in storage and remains free of clusters and hard lumps. They shall flow freely from dispensing Equipment at any time when surface and atmosphere conditions are satisfactory for marking operations. Test the adhesion coating property of the Type IV beads in accordance with the dansyl-chloride test.

C. Black Epoxy Contrast Markings

1. Epoxy Resin Requirements

a. Use a two-component, 100 percent solids, paint epoxy formulated and designed to provide a simple volumetric mixing ratio (e.g. 2 parts component A to 1 part component B) specifically for service as a hot-spray applied binder for black aggregate in such a manner as to produce maximum adhesion. Use Material composed only of epoxy resins and pigments.

2. Black Aggregate Requirements:

a. Use moisture resistant aggregate that has a ceramic coating and is angular with no dry dispensement pigment.

D. Ship the epoxy pavement marking Materials to the job site in strong substantial containers. Plainly mark individual containers with the following information:

1. Name of Product

2. Lot Number

3. Batch Number

4. Test Number

5. Date of Manufacture
6. Date of expiration of acceptance (12 months from date of manufacture)
7. The statement (as appropriate)
    a. Part A - Contains Pigment & Epoxy Resin
    b. Part B - Contains Catalyst
8. Quantity
9. Mixing proportions, Application Temperature, and Instructions
10. Safety Information
11. Manufacturer's Name and Address

E. Ship reflective glass spheres in moisture-resistant bags. Mark each bag with the name and address of the manufacturer and the name and net weight of the Material.

F. The Department reserves the right to randomly take a one-quart sample of white, yellow, and hardener, of the epoxy Material or glass spheres without prior notice for testing to ensure the epoxy Materials and glass spheres meets Specifications.

G. Apply only epoxy markings that meet the following minimum reflectivity values:

1. 450 millicandellas for white lines
2. 325 millicandellas for yellow lines
3. Any single reading shall not be less than 350 millicandellas for white and 250 millicandellas for yellow.

1071.03 Thermoplastic.

A. Alkyd Type Thermoplastic Material

1. Use thermoplastic Material that is available in white and highway yellow that is homogeneously composed of pigment, filter, resins, and glass reflectorizing spheres. It must melt uniformly with no evidence of skins or unmelted particles and 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. Use only thermoplastic Material tested in accordance with AASHTO T 250 and AASHTO M 249 or with the appropriate method in FED-STD-141 or ASTM designation.
2. Furnish a thermoplastic Material that is suitable for application immediately after compaction of the final lift of asphaltic concrete. The thermoplastic Material cannot be permanently discolored nor softened by contact with bituminous concrete.
3. Packaging and Marking:
    a. Package in suitable containers, weighing approximately 50 pounds, to which the Material will not adhere during shipment and storage. Designate the color, binder (alkyd), spray or extrude, user information, manufacturer's name and address, batch number, and date of manufacture on each container. Provide each batch manufactured with its own separate number. Provide on the label a warning to the user that the Material must be heated in the range of 400 to 440 degrees Fahrenheit.
4. Utilize thermoplastic marking application Equipment that conforms to the following requirements:
    a. Provide for constant mixing and agitation of the Material.
    b. Apply the Material to the road surface in a molten state at the temperature specified in Section 817.03.5 by screed/extrusion means.
    c. Apply glass beads instantaneously upon the installed line to ensure adhesion.
5. Apply only alkyd type thermoplastic Markings that meet the following minimum reflectivity values:

a. 300 millicandellas for white lines

b. 200 millicandellas for yellow lines

6. Preformed Thermoplastic Striping

7. Use only Materials listed on the Department's Approved Pavement Markings Material List for this Item. Use preformed retroreflective markings that are fusible to bituminous asphalt pavement by means of the normal heat of a propane type of torch. Adhesives, primers or sealers are not necessary prior to the preformed retroreflective markings application on bituminous asphalt pavement.

8. Conform to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. Use markings that have resealing characteristics and are capable of fusing to itself and previously applied worn hydrocarbon and/or alkyd thermoplastic pavement markings.

9. Use markings capable of application on bituminous asphalt pavement wearing courses during the paving operation in accordance with the manufacturer's instructions and are immediately ready for traffic after application. Use preformed retroreflective markings that are suitable for use for one year after the date of receipt when stored in accordance with the manufacturer's recommendations.

10. Use preformed retroreflective thermoplastic markings that are not brittle and are sufficiently cohesive and flexible at temperatures exceeding 50 degrees Fahrenheit for one person to carry without the danger of fracturing the Material prior to application.

11. Apply only thermoplastic markings that meet the following minimum reflectivity values:

    a. 300 millicandellas for white lines

    b. 200 millicandellas for yellow and blue lines

12. Supply Material that has a minimum average thickness of 0.090 inches for all longitudinal lines and a thickness of 0.125 inches for all transverse lines and symbols/legends.

13. Use markings that once applied are resistant to deterioration due to exposure to sunlight, water, oil, diesel fuels, gasoline, pavement oil content, salt, and adverse weather conditions.

14. Apply the preformed retroreflective pavement markings in accordance with manufacturer's instructions so that they are neat and durable. The markings must remain skid resistant and show no lifting, shrinkage, tearing, roll back or other signs of poor adhesion for a period of one winter season.

15. Furnish the flexible preformed retroreflective thermoplastic marking Materials, for use as transverse or longitudinal markings as well as legends, arrows and symbols in either flat form material or in rolls. Supply flat form Material in maximum of 4 foot lengths up to 2 feet in width. Package the Material, flat form or in rolls, in suitable cartons clearly labeled for ease of identifying the contents.

1071.04 Pavement Marking Tape.

A. Temporary Tape

1. Supply removable retroreflective pavement marking tape that can be readily removed when the markings are no longer applicable.

2. Supply markings, white or yellow retroreflective pavement marking that remain wet and dry reflective throughout its useful life, on flexible backing.

3. Apply only temporary marking tape that meets the following minimum reflectivity values:

    a. 750 millicandellas for white lines

    b. 450 millicandellas for yellow and blue lines

4. Furnish markings that are pre-coated with a pressure sensitive adhesive and capable of being adhered to bituminous concrete or Portland cement concrete at temperatures as low as 50 degrees Fahrenheit in accordance with the manufacturer's recommendations. Use a surface preparation adhesive

recommended by the manufacturer for all applications to improve initial and long term adhesion.

B. Blackout Tape

1. Use a blackout marking tape consisting of a matte black, non-reflective, patterned surface that is pre-coated with a pressure sensitive adhesive and provides a minimum skid resistance value of 45 BPN when tested according to ASTM E303.

C. Preformed Tape

1. Use preformed markings to provide immediate and continuing retroreflection. The markings shall be suitable for application on new or existing Portland cement concrete or bituminous pavements with a pre-coated pressure sensitive adhesive.

   a. The preformed marking Material must be used on the project prior to one year from date of manufacture.

   b. Use a surface preparation adhesive, when not placed by inlaid method.

   c. Use only markings capable of providing retroreflection during both wet and dry conditions.

   d. Use markings designed for longitudinal and word/symbol markings subjected to high traffic volumes and severe wear conditions such as shear action from crossover or encroachment on typical longitudinal configurations such as edge lines and lane lines. Do not use lead chromate pigments or other similar, lead-containing chemicals for the manufacture of these Materials.

2. Use white and yellow markings that have the initial expected retroreflectivity values as shown in the table below under dry and, wet, and rainy conditions. The photometric quantity to be measured shall be the coefficient of retroreflected luminance (R_L) and expressed as millicandelas per square foot per foot-candle [$(mcd \cdot ft^{-2}) \cdot fc^{-1}$].

   a. Retroreflectivity values will be measured under dry conditions in accordance with the testing procedures of ASTM D4061 and will meet or exceed the values specified in the table below. Submit manufacturer's certification that retroreflectivity values under wet conditions meet the values in the table below and have been tested in accordance with ASTM E2832 or ASTM E2177. Wet retroreflectivity values measured under a "condition of continuous wetting" (simulated rain) will be performed in accordance with ASTM E2832. Wet retroreflectivity values measured under a "condition of wetness" will be performed in accordance with ASTM E2177.

   b. Expected Initial R_L under dry, wet, and rainy conditions

White Markings	Dry	Wet & Rainy
Entrance Angle	88.76°	88.76°
Observation Angle	1.05°	1.05°
Retroreflected Luminance	500 millicandelas	250 millicandelas

Yellow Markings	Dry	Wet & Rainy
Entrance Angle	88.76°	88.76°
Observation Angle	1.05°	1.05°
Retroreflected Luminance	300 Millicandelas	250 Millicandelas

   c. Use a pavement marking Material capable of use for patching worn areas of the same type in accordance with manufacturer's instructions.

1071.05 Raised/Recessed Pavement Markers.

A. Use a cast iron housing that is snow plowable and meets the requirements of ASTM A 536, Grade 72-45-84.

B. Use reflectors that meet the requirements of ASTM D 4383.

C. Provide pavement marker color combinations in accordance with the DE MUTCD.

D. Use an epoxy that meets the requirements of AASHTO M 237, Type IV.

E. Submit material cut sheets to the Engineer for approval prior to installation.

F. Inspection and Testing

1. More detailed information concerning these Materials is available by contacting the Department's Materials and Research Section, (302) 760-2400.

2. Submit certification from the manufacturer showing that the Materials supplied meet the requirements of this Specification.

3. Upon notification of award, the vendor is to contact the Department's Materials and Research Section to arrange for sampling and testing of approved Materials.

4. The vendor is to supply all samples required by the Department's Materials and Research Section 30 Days prior to use in amounts and sizes indicated, at no cost to the Department.

SECTION 1072 – SIGN POSTS

1072.01 Galvanized Telescoping Steel Sign Posts.

A. Square tube formed from Galvanized Sheet Structure (Physical) Quality

1. ASTM A653, Grade A
2. Coating designation G90

B. Regular Spangle or formed from Hot Rolled Carbon Sheet Steel Structural (Physical) Quality

1. ASTM A504, Grade 50

C. Use 12 gauge steel for all square tubes.

D. Cold rolled steel is to be hot-dipped galvanized

1. ASTM A653, latest revision
2. Coating designation G90, Grade 50, Class 1 with regular spangle.
3. Damage to finished coating is not permitted.
4. Protect exposed edges against corrosion by sacrificial action when zinc is present on intimate adjacent areas.
5. Galvanize both the interior and exterior of the post.

E. Hot rolled steel, after forming, is to be hot-dipped galvanized

1. ASTM A653, latest revision
2. Minimum coating of 0.90 ounce per square foot when tested according to ASTM A653 G90.
3. Keep all holes and end openings free of excess amounts of zinc.

F. Permissible Tolerances:

1. Wall thickness dimension of 0.1084 inch ± 0.008 inch.
   a. Note: The thickness includes both the base metal and the galvanized coating.
2. Nominal outside dimensions, inches:
   a. 2 x 2 ± 0.008
   b. 2-1/4 x 2-1/4 ± 0.010
   c. 2-1/2 x 2-1/2 ± 0.010
   d. Note: Check measurements for outside dimensions at least 2 inches from end of tube.
3. Convexity and concavity to be measured in the center of the flat sides, tolerances being ± 0.010 inch applied to the specific size determined at the corner.
4. Permissible variation tolerance in straightness is 1/16 inch in 3 feet.
5. Length tolerance on standard length members with holes shall be ± 2-1/8 inches.

G. Holes: All four sides are to have evenly spaced 7/16 inch diameter holes on 1 inch centers the entire length of the tube.

1. Tolerance on hole size is ± 1/64 inch.
2. Tolerance on hole spacing is ± 1/8 inch in 20 feet.

H. Fabrication: Furnish members that are straight and have a smooth uniform finish, with all holes and cut off ends free from burs. It shall be possible to telescope consecutive sizes of tubes freely for 9 foot, 10 foot, 11 foot, and 12 foot with a minimum amount of play.

I. Corner Radii: Standard corner radius of 5/32 inch ± 1/64 inch.

J. Weld Flash: Interference of telescoping properties from the corner weld and weld flash is not permitted.

K. Fasteners: Supply 5/16 inch Grade 5 unified coarse thread (UNC) corner bolts and nuts, in conformance to ANSI B1.1, with zinc plating.

L. Basepost: Furnish galvanized basepost sections with dimensions of 18 inch x 2.5 inch and 36 inch x 2.25 inch in accordance with Standard Construction Details.

M. Shipping

1. Take care in shipping to minimize the rubbing of posts against each other with resulting damage.

2. Damage to the finish of the posts in shipping will be cause for rejection of the damaged posts as determined by the Engineer.

N. Submit FHWA Acceptance Letters documenting satisfaction of NCHRP Report 350 or MASH crash testing requirements.

1072.02 Wooden Sign Posts.

A. Submit FHWA Eligibility Letters documenting satisfaction of NCHRP Report 350 or MASH crash testing requirements.

B. Use treated, Grade 2 air-dried southern yellow pine meeting the requirements of Section 1041.

1072.03 Breakaway I-Beam Sign Posts.

A. Supply the I-beams and all mounting hardware.

1. Supply breakaway I-beam sign supports and mounting hardware that have been successfully crash tested in accordance with NCHRP Report 350 or MASH testing criteria.

2. Submit FHWA Eligibility Letters and supporting documentation.

B. Supply structural steel in accordance with Section 615.02 of the Standard Specifications.

C. Breakaway Couplings:

1. Alloy steel which conforms to AISI 4340, 4130 or an equivalent Material

2. Minimum tensile yield stress of 175,000 pounds per square inch.

3. The Rockwell C hardness a minimum of 26.

4. Use couplings with tensile breaking strength ranges as noted below, and of the type in accordance with the Contract Documents:

Type A	17,000-21,000 pounds
Type B	47,000-57,000 pounds

5. Steel meeting requirements of ASTM A 370.

6. Furnish couplings that are clean, dry and free from any foreign material and primed and coated with a suitable paint that is baked or fused with a polyurethane additive. Provide color of the coating as follows:

Type A	Yellow
Type B	Red

7. Repair all damaged areas of the coating surface. Clean all threaded surfaces, after coating.

D. Brackets:

1. Aluminum alloy 6061 T-6 or an equivalent Material.
2. Upper brackets shall incorporate the load concentrating member or base which shall be made from the following material:

Type A	Aluminum alloy 6061 T-6 or equivalent as part of brackets
Type B	Stainless steel 416 or equivalent ASTM A582 steel with Rockwell hardness classification of C35-C45 tested in accordance with ASTM E18.

3. The type of base shall be as shown on the Plans.
4. Position so that the location holes for the breakaway coupling are relative to the load concentrating member in accordance with the Engineer's requirements. Permanently label all brackets with bracket number to reflect the hole positioning.

E. Hinge Plates:

1. Alloy steel which conforms to AISI 4340, 4130 or an equivalent Material
2. Minimum tensile yield stress of 90,000 pounds per square inch.
3. Use hinge plates that have tensile breaking strength ranges as follows and in accordance with the Contract Documents:

HI-10	11,450-13,900 pounds
HI-1	16,400-19,700 pounds
HI-2	6,700-8,100 pounds

F. Nuts, Bolts and Cap Screws

1. ASTM A 325.
2. All nuts, bolts and cap screws shall be within a hardness range of Rockwell C23 to C31 prior to hot-dip galvanizing per AASHTO M232/M 232M.

G. Reinforced Concrete Masonry Sign Foundation:

1. Bar Reinforcement
   a. Section 1037 of the Standard Specifications.
2. Portland Cement Concrete, Class B meeting the requirements of Section 1022 of the Standard Specifications.
3. Anchor Bolts
   a. Fabricated from 304 Stainless Steel for the threaded ferrule portion
   b. Fabricated from 1058 steel rod and coil for cage portion of anchor.
4. Nuts, Bolts and Cap Screws
   a. ASTM A 325.
   b. All nuts, bolts and cap screws shall be within a hardness range of Rockwell C23 to C31 prior to hot-dip galvanizing per AASHTO M232/M 232M.

SECTION 1073 – DELINEATORS

1073.01High Performance Flexible Plastic Delineators.

A. Delineator posts:

1. Flexible plastic, resistant to impact, ultra violet light, ozone, hydrocarbons, and remain impact resistant from -30 degrees Fahrenheit to 140 degrees Fahrenheit.

2. Provide a post exhibiting good workmanship and free of burns, discoloration, contamination, and other objectionable marks or defects which affect appearance of serviceability.

B. Reflector:

1. Use impact resistant prismatic retroreflective sheeting meeting the requirements of the current ASTM D 4956.

1073.02 Post-Mounted Delineators.

A. Delineators

1. Sheet aluminum meeting the requirements of ASTM B209 (alloy 6061-T6 or 5052-H38) covered with prismatic retroreflective sheeting meeting the requirements of the current ASTM D 4956.

2. Use delineator blank 3-1/4 inches in diameter.

3. Sheet aluminum cover and reflective sheeting are each 0.063 inch thick.

4. Provide Material for aluminum and hardware to be approved by Engineer.

B. Posts

1. Steel posts for post mounted delineators and hazard markers must be a "U" channel section weighing approximately 1.12 pounds per foot.

2. Posts shall be punched with at least three (3) 3/8 inch holes on the centerline, spaced at 4 inch centers beginning 1-1/2 inches from the top.

3. Punch holes prior to galvanizing of the posts.

4. Use steel conforming to the provisions of ASTM A 36, and galvanize after fabrication in accordance with the provisions of ASTM A 123.

1073.03 Barrier Mounted Delineators.

A. Delineators. Furnish high impact barrier mounted delineators meeting the following requirements.

1. Impact resistant engineering grade thermoplastic Material that bends upon impact and rebounds to original shape and contains UV-stabilized polymers.

2. Pre-drilled holes for bolt and stud mounting.

3. Minimum 12 square inches of prismatic reflective sheeting meeting the requirements of current ASTM D 4956.

4. Mounting adhesive meeting delineator manufacturer’s requirements.

B. Retroreflective Sheeting. Use sheeting colors as follows:

1. On any divided highway or one-way roadway/ramp, equip the surface facing traffic with white or silver sheeting on the right side of the roadway and yellow sheeting on the left side of the roadway. Equip the back surface of all of the delineators with red reflective sheeting.

2. On any undivided highway, equip all delineators with white or silver sheeting on the front and back.

SECTION 1074 – ELECTRICAL CABLE AND SPLICING

1074.01 Electrical Cable.

A. Electrical Cable and Wire, NEC, 600 V, UL approved.

1. Stranded or solid, single conductor copper cables (XLP insulated)

   a. USE or RHW rated as noted on the Plans.

   b. THHN or THWN rated as noted on the Plans.

2. Bare or Insulated stranded copper grounding wire

3. Triplex aluminum service cable

4. Type UF cable with ground

   a. Include ground and the number and size of conductors as shown in the Contract Documents.

   b. Conform to UL 493.

B. Traffic signal cable, solid copper conductor

1. Conform to IMSA Specification number 19-1

2. Provide wire size and number of conductors as shown in the Contract Documents and as directed by the Engineer.

3. Independent test results to verify Specification compliance.

   a. Costs of testing are incidental to the cable Item being supplied.

4. Supply cables on reels with each reel containing one continuous length of cable.

5. Use color code as established by IMSA Specifications.

   a. Use individual tracers that contrast with the base color to allow easy identification.

   b. To test for sufficient color contrast, remove the sheath for a length of 6 inches. Remove all filler material and tapes for the same length. Place all conductors of the same base color side by side and hide all other conductors.

6. The tracer line width shall not exceed 3/20 inch when measured perpendicular to the edge of the line.

7. The total width of tracer lines on a conductor must be less than one-half the total circumference of the conductor.

C. Emergency Pre-emption Receiver Cable.

Provide 4-conductor #18 AWG Shielded Opticom Cable that meets the pre-emption receiver manufacturer's recommended specifications.

D. Home Run Cable.

1. Provide 2-conductor #14 AWG Aluminum Shielded Cable.

2. Shielded two conductor controlled capacitance cable enclosed in an aluminized polyester shield within a polyethylene jacket, rated at 600 volts.

3. Cable to conform to IMSA 50-2.

4. The two conductors are AWG # 14 stranded copper.

1074.02 Cable Splicing.

A. Lighting Cable Splicing

1. H-Tap, C-Tap and Butt Splice Compression Connectors in junction wells or transformer bases:

a. Fabricated from high strength copper alloy.

b. Plated connectors fabricated from metals other than copper are prohibited.

c. Bolted type connectors are utilized for splicing bare ground conductors.

d. Compression connector is wrapped in 2 layers of vinyl tape and 2 layers of rubber tape. Tape is "half-lapped" around connector.

i. Vinyl tape is 3M Company, Inc. (Cat. No. 33); Plymouth Rubber (Cat. No. 3117); Permacel (Cat. No. P29), or an approved equal.

ii. Rubber tape is 3M Company, Inc. (Cat. No. 130C, 2228); Plymouth Rubber (Cat. No. 2212); Permacel (Cat. No. 253, P280), or an approved equal.

2. Submersible, breakaway connector kits in lighting transformer bases:

a. Unfused, quick disconnect inline connector kit containing:

i. A copper pin that can be crimped to a conductor.

ii. A receptacle having a centrally located, recessed locking socket constructed so that it is filled and retained by its housing and a disposable assembly pin.

iii. A plug housing for retention of the copper pin.

iv. A receptacle housing with disposable protective sleeve.

b. Fused, quick disconnect inline connector kit containing:

i. A pair of spring loaded copper fuse contacts suitable for gripping the specified cartridge fuse.

ii. A fuse of specified amp rating, rated 600V, 100,000 amps AIC in conformance with UL508.

c. Fused, quick disconnect Y connector kit containing:

i. A pair of spring loaded copper fuse contacts suitable for gripping the specified cartridge fuse. Crimp one contact on a conductor and after insertion into its proper position within the load side plug housing, securely retain it therein. Preassemble the other contact for retention within a Y insert body.

ii. A line side Y housing with two water seal cable ports.

iii. Two terminal lugs, each having a mounting hole.

iv. A bolt and a self-locking nut.

v. A Y insert body with preassembled line side fuse contact and a ring tongue terminal.

vi. A load side plug housing permanently marked "Load Side".

vii. A disposable assembly pin.

viii. A fuse of specified amp rating, rated 600V, 100,000 amps AIC in conformance with UL508.

d. Unfused, quick disconnect Y connector kit containing:

i. A copper pin that can be crimped to a conductor and suitable for retention in the load side receptacle housing.

ii. A Y insert body with preassembled load side copper socket and ring tongue terminal.

iii. A line side Y housing with two water seal cable ports.

iv. Two terminal lugs, each having a mounting hole.

v. A bolt and self-locking nut.

vi. A load side receptacle housing.

e. Each kit contains sufficient silicone compound to lubricate metal parts and the housing for each assembly along with complete installation instructions.

f. All housings are made of water resistant synthetic rubber suitable for burial in the ground or exposure to sunlight.

g. Each housing forms a watertight seal around the cable at the point of disconnection and between the insert body and enveloping Y housing.

h. All copper pins, sockets, and fuse contacts have a minimum conductivity of 90 percent.

i. The crimped portion is fully annealed while the rest of the device is maintained in its original state.

j. Use rigid, molded insulating plastic sleeve Material of sufficient outside diameter to form a watertight fit with its related housing.

k. One contact is crimped on a conductor and after insertion into its proper position within the load side plug housing, is capable of being securely retained.

l. Preassemble the other contact for retention within the line side of the connector body.

B. Tape – Use a vinyl electrical tape that has a PVC base with rubber based pressure sensitive adhesive, a minimum of 7 mils thick and UL listed and marked per UL Standard 510 as flame retardant and cold resistant. Use a tape compatible with synthetic cable insulations, jackets and splicing compounds and rated for wire and cable splices up to 600-volts.

C. For splices in Junction Well (see Standard Construction Details):

1. Dual Wall Heat Shrink Tubing – Use a heat-shrink tubing that is a medium or heavy wall thickness, irradiated polyolefin tubing containing an adhesive mastic inner wall. Minimum wall thickness prior to contraction of 40 mils. When heated, the inner wall melts and fills all crevices and interstices of the object being covered while the outer wall shrinks to form a waterproof insulation. Provide an overlap of the conductor insulation at least 1-1/2inches at each end of the heat-shrink tube or the open end of the end cap of heat-shrink tubing after contraction. Provide heat-shrink tubing that conforms to the requirements in and ANSI C119.1, for extruded insulated tubing at 600 volts.

2. Soldering iron with Rosin Core solder

3. Splicing kit – In-line barrel type design, resin encapsulating compound kit with UL486D rating. Suitable for use in wet or direct buried locations. Use only resin encapsulating compounds that are acceptable for use at 61 degrees Fahrenheit.

SECTION 1075 – TRAFFIC SIGNAL HEADS

1075.01 LED Traffic Signal and Pedestrian Signal Modules.

A. Provide Materials and workmanship in conformance with the standards of the American Society for Testing Materials (ASTM), latest edition, and the standards of the American National Standards Institute (ANSI), latest edition, where applicable.

B. Provide all electrical Equipment conforming to the standards of the National Electrical Manufacturer's Association (NEMA), the Underwriters Laboratories, Inc. (UL), and the Institute of Electrical and Electronic Engineers, Inc. (IEEE), wherever applicable (latest edition).

C. Use good practice as recommended by the manufacturer and/or as used by the industry in general, for those Items not specifically defined herein. A representative of the Department will be available to discuss good practice and "state of the art". Neither claims for additional cost nor extensions of delivery times will be honored on the basis of good practice and/or "state of the art" issues.

D. Show by field review, if necessary, and by the various documents that are required as part of the Bid, that the Materials proposed will perform as required.

1075.01.1 LED Traffic Signal Modules.

A. Provide all LED modules for vehicle traffic signal heads conforming to the current ITE and Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) requirements.

B. This Specification refers to criteria described in "ENERGY STAR Program Requirements for Traffic Signals." ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy.

C. Provide the Circular LED Modules in one of six types, as required by the Contract Documents:

1. 8 inch Red Circular LED Module
2. 8 inch Yellow Circular LED Module
3. 8 inch Green Circular LED Module
4. 12 inch Red Circular LED Module
5. 12 inch Yellow Circular LED Module
6. 12 inch Green Circular LED Module

D. Provide the Arrow LED Modules in one of three types, as required by the Contract Documents:

1. 12 inch Red Arrow LED Module
2. 12 inch Yellow Arrow LED Module
3. 12 inch Green Arrow LED Module

E. The following are the detail Specifications for Circular and Arrow LED Modules. Meet all Specification requirements even if a particular location may not require all of the specified elements.

1. Physical and Mechanical Requirements:

a. Use a module that fits into a traffic signal housing built to ITE VTCSH standards without modification to the housing. Utilize the same mounting hardware used to secure the assembly to the traffic signal section, when replacing an incandescent reflector assembly the module. Do not use "Screw-in" type modules in the vehicle traffic signal heads. Install module into signal housing without the use of special tools.

b. Provide a self-contained module that, requires no on-site assembly for installation into an existing traffic signal housing. Equip the module with two (2) conductors for connecting to power, a

printed circuit board, power supply, lens and one-piece gasket, and seal the unit after installation and connections are made so that it is weatherproof. The power supply shall be integral to the module.

c. There are no restrictions to any specific LED technology for the module.

d. Equip the module and removable lens with a prominent and permanent vertical indexing indicator, i.e., UP arrow, or the word "UP" or "TOP", for correct indexing and orientation in the signal housing.

e. Affix a certification label to the back of the module that the module is in conformance to all non-optional requirements of VTCSH-LED or VTCSH-ARROW and the complete ITE standards.

2. Environmental Requirements:

a. Provide a module lens capable of withstanding ultraviolet exposure for minimum period of 60 months without exhibiting significant evidence of deterioration.

3. Optics Requirements:

a. Submit the Maintained Minimum Luminous Intensity tables for the expanded or extended view modules with the Bid Proposal. Show, at a minimum, the points corresponding to the intensity tables provided in VTCSH-LED and VTCSH-ARROW.

b. Equip arrow modules with a solid arrow indication in conformance with VTCSH, Chapter 2, Section 9.01 having a three line / horizontal bar. Spread the LEDs evenly across the illuminated portion of the arrow area.

4. Lens Requirements:

a. Provide an abrasion resistant module lens that has a smooth outer surface to reduce the collection of debris and facilitate cleaning; and made of ultraviolet stabilized polycarbonate or polymeric Material.

b. A module lens, tinted or covered by transparent film or Materials with similar color and transmissive characteristics, is permitted.

c. The lens may be a replaceable part without the need to replace the complete module. Provide a lens that delivers an overall appearance that mimics that of one used with incandescent lamps. Lenses that depict a "honeycomb" effect of the display are unacceptable.

5. Electrical Requirements:

a. Equip the module to connect directly to the existing electrical wiring system, with a nominal operating voltage of 120 +/- 3 VAC RMS. Operate the module using a 60 hertz +/- 3 hertz AC line power over a voltage range from 80 VAC RMS to 135 VAC RMS. Prevent flicker of the LED output at frequencies less than 100 hertz over the operating voltage range. Fluctuations in line voltage over the operating voltage range that affect luminous intensity by more than +/- 10 percent are not permitted. Visible illumination from the module when the applied voltage is less than 35 VAC RMS is not permitted.

b. Provide modules that meet the maximum and nominal wattage requirements of "ENERGY STAR Program Requirements for Traffic Signals," current edition.

c. Provide wiring and terminal blocks that meet the requirements of VTCSH, Chapter 2, Section 13.02. Provide two (2) secured, color coded, 600 volt, jacketed wires, a minimum of 18 AWG and at least 39-inches in length, conforming to the NFPA 70, National Electrical Code, and rated for service at 221 degrees Fahrenheit.

d. Wire the individual LEDs such that a catastrophic failure of one LED will result in the loss of not more than 5 percent of the module total light output. Wire the LEDs so that with the outage of a single LED will not cause the outage of additional LEDs.

e. Provide modules that are operationally compatible with currently used controller assemblies (solid state load switches, flashers and conflict monitors).

f. Provide LED signal heads that are operationally compatible with NEMA traffic controller assemblies meeting the standards set forth in NEMA Standards Publication TS-2 Traffic Controller Assemblies, latest edition. Provide LED modules that are operationally compatible with NEMA TS-1 and TS-2 conflict monitoring parameters.

g. Use the control circuitry to prevent the current flow through the LEDs in the off state to avoid any false indication as may be perceived by the human eye during daylight and evening hours.

h. Provide LED signals that are fully capable of operating in the flashing mode.

i. A dimming feature is not required.

1075.01.2 Pedestrian Head LED Modules.

A. Provide LED module conforming to the Institute of Transportation Engineers (ITE), Pedestrian Traffic Control Signal Indicators: Light Emitting Diode (LED) Signal Modules, dated February 2011.

B. Establish the size, design and illumination of Pedestrian Signal Display Indications in conformance to the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), latest edition and the Standard Highway Signs and Markings, latest edition.

C. Provide each module as a fully encapsulated assembly that utilizes LEDs as the light source and a message lens. Wire the individual LEDs such that a failure of one or more LEDs will result in the loss of light from that LED only and the loss of not more than one (1) percent of the module light output. Provide ultra bright type LEDs rated for 100,000 hours of continuous operation.

D. Display messages in the Portland Orange "Upraised Hand" ("Hand"), the White "Walking Person" ("Person") and the Portland Orange "Numeric Countdown" ("Countdown") icons illuminated by multiple configuration LEDs.

E. Provide "Hand" and "Person" icons each with a minimum of 11 inches in height and 7 inches in width. Provide "Countdown" icon with two 7 segment digits, forming the time display, at a height of 9 inches and the overall width of the digit display (both digits side-by-side) of 7 inches, with 0.5 inches of space between the two digits.

F. Include the "Hand" and "Person" icons on all modules. If the "Countdown" icon is used in conjunction with the "Hand" and the "Person" icons, overlay the "Hand" and the "Person" icons upon each other and locate the overlaid icons to the left of the "Countdown" icon. If the "Countdown" icon is not used, arrange the "Hand" and "Person" icons side-by-side with the "Hand" icon to the left of the "Person" icon.

G. Electrical Requirements:

1. Provide a module conforming with the electrical requirements of the Institute of Transportation Engineers (ITE), Pedestrian Traffic Control Signal Indicators: Light Emitting Diode (LED) Signal Modules, dated February 2011. Keep power consumption to not exceed 15 watts for the "Hand" icon, 10 watts for the "Person" icon and 10 watts for the "Countdown" icon at a temperature of 77 degrees Fahrenheit. Keep the individual LED driving current less than 10 milliamps for each icon at a temperature of 77 degrees Fahrenheit.

2. Operate the module using a 60 hertz ± 3 hertz AC line over a voltage ranging from 80 volts to 135 volts, with a nominal operating voltage of 120 ± 3 volts. Fluctuations in line voltage within the range of 80 volts to 135 volts that affect luminous intensity by more than ± 10 percent are not permitted. When input voltage is less than 35 volts, equip the module to turn off automatically. Provide a module that has each icon reach 90 percent of their full illumination (turn-on) within 75 milliseconds of the application of the nominal operating voltage. Provide a module that will not be illuminated (turn-off) after 75 milliseconds of the removal of the nominal operating voltage. Equip the module to include

voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.8 of NEMA Standard TS-2, latest edition.

3. Provide a module that has a power factor (PF) greater than 0.9, and a total harmonic distortion (THD) less than 20 percent when at a temperature of 77 degrees Fahrenheit.

4. Electromagnetic Interference (EMI) meeting Class A emission limits referred to in the Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulation.

5. Provide each signal with one individual set of wires for electrical connections. Each set must be made of tree secured, color coded (blue, red, white), 36 inches long, 600V, 16 AWG jacketed wires, rated for service at +221 degrees Fahrenheit.

H. Photometric Requirements:

1. Provide photometrics conforming with the Institute of Transportation Engineers (ITE), Pedestrian Traffic Control Signal Indicators: Light Emitting Diode (LED) Signal Modules, dated February 2011. Provide a minimum luminous intensity for a minimum period of 60 months of 409 footlamberts for the "Hand" icon, 642 footlamberts for the "Person" icon and 409 footlamberts for the "Countdown" icon. Provide uniformity of the "Hand", "Person" and "Countdown" luminance to meet a ratio of not more than one (1) to five (5) between the minimum and maximum luminance values as measured in 1/2 inch diameter spots.

I. Chromaticity:

1. Ensure the measured chromaticity, coordinating the white "Person" and the Portland Orange "Hand" and "Countdown" icons, is in conformance to the chromaticity requirements of Section 4.2 and Figure 5 of the ITE Pedestrian Traffic Control Signal Indicators: Light Emitting Diode (LED) Signal Modules, dated February 2011.

2. Ensure the chromaticity measurements remain unchanged over the input line voltage range of 80 VAC to 135 VAC.

J. Flashing Requirements:

1. Provide a light source of a flashing "Hand" signal indication capable of flashing continuously at a rate of not less than 50 or more than 60 times per minute, with each flash a minimum of 1/2 and a maximum of 2/3 of the total flash cycle.

K. Environmental Requirements:

1. Protect the module against dust and moisture intrusion per the requirements of MIL-STD-810F Procedure I, Rain and Blowing Rain. Provide a module with an Ingress Protection (IP) rating of at least 54 and meets all Specifications in the operating temperature range of -40 degrees Fahrenheit to +165 degrees Fahrenheit.

L. Message Lens:

1. Provide a message lens made of plastic and has a smooth outer surface. Provide an ultraviolet-stabilized lens capable of withstanding ultraviolet (direct sunlight) exposure for a minimum of 60 months. Provide the message lens with the inside painted in black in all areas except where the desired icons are formed to form a contrasting background when viewed from the outside.

M. Installation Requirements:

1. Provide a module capable of replacing the existing optical components or signal module in a signal housing, or by a complete replacement of the signal head. If installation of a module is into an existing housing, install module without the use of special tools and with connection made directly to the existing electrical wiring system.

1075.01.3 Module Identification and Marking Tag.

A. Permanently mark on the backside of LED Traffic Signal Modules and Pedestrian Head LED Modules the manufacturer's name, trademark (if applicable), date code, operating characteristics, part/model number and serial number. Include with the operating characteristics, the nominal operating voltage and stabilized power consumption, in watts and volt-amperes.

B. Securely install a tag on each LED Module indicating the Prime Contractor, Contract Number, Module Supplier, Date of Purchase and Date of Installation.

1075.01.4 Quality Acceptance.

A. Manufacture LED Traffic Signal Modules and Pedestrian Head LED Modules in accordance with a qualified ISO 9001, latest edition vendor quality assurance program. Test each module for minimum maintained luminous intensity for expended or extended viewing angle products, in addition to tests specified in the ITE VTCSH – Part 3: Light Emitting Diode (LED) Vehicle Arrow Signal Modules, latest edition, LED Quality Assurance Program. Failure of each supplied module to meet requirements of all these tests will be cause for the modules to be rejected.

1075.01.5 Certification of Compliance.

A. Provide, upon request, a Certificate of Compliance from the manufacturer certifying that the modules comply with the requirements of these Specifications. Include a copy of all applicable test reports that the modules underwent with the certificate. Provide a list of module serial numbers with each shipment and provide this information upon receipt of shipment by the Department's Signal Construction Section, 14 Sign Shop Road, Dover, DE 19901.

1075.01.6 Warranty.

A. Extend any policy guarantee usually offered to purchasers on article(s) and/or service(s) against defective Material and workmanship. Replace, free of charge, any part or component that fails in any manner by reasons of defective Material, design or workmanship within a period of five (5) years from the date of payment for the article(s). Renew the warranty for each part or component for another five (5) years from the date of replacement of the article(s). Consider the entire module failed if it exhibits light output degradation that falls below the minimum intensity level as outlined in this Specification.

B. Supply a certificate of warranty from the manufacturer with the Bid Documents.

1075.01.7 Manuals.

A. Supply a complete set of documentation that includes, but is not limited to, parts lists, operation details, maintenance schedules, and other information needed to install and operate the article(s).

1075.02 Signal Backplates.

A. Furnish backplates with a flat, dull black (Federal Standard color number 595B-37038) Powder Coated Aluminum, of a 0.05 inch minimum thickness and securely mounted on the signal housing. Mount backplates to traffic signal faces using stainless steel self-tapping screws. Manufacture signal head backplates for use with standard signal head assemblies, and compatible with the signal heads being backplated, to the dimensions of backplates in accordance with the Contract Documents. Provide a minimum 2-inch wide yellow border, comprised of ASTM D 4956, Type IV (minimum) retroreflective sheeting around the perimeter of the backplate.

1075.03 Signal Head Housings.

A. Supply the adjustable traffic signal heads in yellow (Federal Standard color number 595B-13538) with a black face conforming to Federal Standard color number 595B-17038.

B. Provide signal head housings, die cast of corrosion resistant aluminum alloy per ASTM B 85, Alloy 12A with full 12 percent Silicon.

C. Clean all interior and exterior surfaces of the housing, housing door and visor and then treat with a chromate aluminum oxide coating process per MIL-DTL-5541. Provide a finish coat using an oven bake

enamel in conformance with Master Painters Institute's Reference #9 and #94 or an epoxy powder coating at least 2.0 mils thick in conformance to ASTM B 117 after 500 hours of salt spray test and have 50 percent gloss retention after 1000 hours of weathermeter test. Use 18-8 type 304 stainless steel for all straight pins, wing nuts, washers and bolts.

D. Design each 8 inch signal section housing to accommodate 8 inch nominal dimension incandescent reflector assemblies or LED modules. Design each 12 inch signal section housing to accommodate 12 inch nominal dimension incandescent reflector assemblies or LED modules. Provide a housing of each signal section consisting of a one-piece corrosion resistant aluminum alloy die-casting with front, side, top and bottom integrally cast, with all parts clean, smooth and free from flaws, cracking, blowholes, or other imperfections. Furnish a housing of substantial thickness and ribbed so as to produce the strongest possible assembly consistent with light weight. Equip the housing with internal bosses for the mounting of terminal strip facilities.

E. Equip the top and bottom of the housing with an opening to accommodate standard 1-1/2 inch nominal diameter pipe and a Shurlock boss integrally cast into the housing.

F. Equip the housing with hinges, as lugs cast onto the side of the housing or inside the housing, and locking devices for the door.

G. Provide a one-piece, corrosion resistant, aluminum allow die-casting, in black (Federal Standard color number 595B-17038) housing door for each section. Provide two (2) hinge lugs cast on one side of the door and two latch points cast on the other side. Attach the door to the housing by means of two (2) straight pins. Equip the door with two (2) eye bolts and wing nuts on one side to allow the door to open and close without the use of any tools. Provide a gasket groove on the inside of the door to accommodate a weatherproof and mildew-proof resilient gasket which, when the door is closed, seals against a raised bead on the housing, making a positive seal. Equip the outer face of the door to have four (4) holes equally spaced about the circumference of the lens opening, with four (4) screws to accommodate a signal head visor. Equip the door to have at least two (2) index points to enable positive orientation of the lens.

1075.04 Visors.

A. Provide visors, Full Circle, Tunnel or Cap, as shown in the Contract Documents; formed of corrosion-resistant aluminum alloy sheet not less than 0.05 inch in thickness. Provide visor(s) with a minimum of 7 inches in length for nominal 8 inch sections and 9-1/2 inches in length for nominal 12 inch sections, with a downward tilt of 3-1/2 degrees. Equip visors with twist-on attaching slots so that they can be removed by simply loosening, not removing the mounting screws and rotating the visor.

B. Coat visors, both inside and outside, with flat black meeting Federal Standard color number 595B-37038.

1075.05 Banding Hardware.

A. Furnish BAND-IT 3/4 inch, 0.030 inch thickness, stainless steel banding Material and 3/4 inch stainless steel buckles, per Contract Documents for signal head mounting.

1075.06 Pedestrian Signal Housing.

A. Furnish each pedestrian signal display housing consisting of a yellow case housing, complete with a black housing door, field terminal assembly and visor. Provide housing with the maximum overall dimensions not exceeding 18.5 inches wide by 18.7 inches high by 9.1 inches deep including visor.

B. Provide a one-piece housing of a corrosion resistant aluminum alloy die-casting free of defects such as cracks and burrs, in the color yellow, Federal Standard 595B-13538. Equip the housing with top and bottom openings to accommodate 1-1/2 inch pipe brackets and have a Shurlock boss, or approved equal, integrally cast into the housing. Provide positive five (5) degree increment positioning of the entire signal display to eliminate rotation or misalignment of the signal display with radial angular grooves of the Shurlock boss, when used with Shurlock fittings. Equip the housing with two (2) integrally cast hinge lugs and screw slots on each side. Provide a housing capable of providing a swing down housing door.

C. Provide a one-piece housing door of a corrosion resistant aluminum alloy die-casting in the color black, Federal Color 595B-17038. Equip the housing door with two (2) hinge lugs cast on top, and two (2) latch points cast on the bottom. Attach the door to housing by two (2) hinge pins. Provide two (2) eye bolts and wing nuts for opening and closing the door without the use of special tools. Provide a gasket groove on the inside of the door to accommodate a weatherproof and mildew proof resilient gasket which, when the door is closed, will seal against a raised bead of the housing, making a positive seal.

D. Equip the field terminal assembly with a three (3) terminal pair (6 screw) type terminal block for termination of the three (3) field #14 AWG spaded terminal wires for AC (+) for the "Hand" and "Person" icon and AC (-). Equip the side of the terminal with a male quick disconnect blade that mates with the insulated female quick disconnect lug supplied on the LED Module. Bolt an aluminum base plate to the signal display housing for the field terminal assembly.

E. Design the visor to eliminate sun phantom and minimize damage to the LED Module and provide in flat black, Federal Color 595B-37038. Install the visor parallel to the face of the signal display, held in place by stainless steel screws. Provide the visor assembly with a minimum of 20 straight louvers and 21 zigzag pattern horizontal louvers.

F. Prior to assembling, thoroughly clean all aluminum elements and apply a chromate conversion coating inside and out as per Military Specification MIL-DTL-5541. Electro-statically apply a synthetic enamel conforming to Military Specification TT-E-529. Provide finish, oven cured for at least 20 minutes at a temperature of 350 degrees Fahrenheit. Supply the signal display housing in yellow with a black door. Provide a dustproof, weatherproof and corrosion resistant signal display as installed.

G. Provide all Materials required to mount the LED Countdown Signal Assemblies in accordance with the Contract Documents.

1075.07 LED Pedestrian Pushbutton Assembly.

A. Provide pedestrian pushbutton assembly conforming to all minimum size requirements set forth by the Americans with Disabilities Act (ADA). Design the pushbutton assembly to prevent electrical shock under any weather conditions and have provisions for grounding in accordance with the National Electrical Code (NEC). Supply each pedestrian pushbutton assembly to include the pushbutton housing complete with front cover and a push button switch. Equip the LED pushbutton assemblies with a LED/audible indicator. Supply any control Equipment necessary for the pushbutton assemblies to operate as specified herein as necessary at no additional charge. Assume an average of six (6) pushbutton assemblies per intersection for the purposes of distributing control Equipment costs. Supply control Equipment to fit into a standard traffic signal control cabinet.

B. Supply the pushbutton housing in yellow (color number 595B-13538) cast aluminum. Design the rear of the housing curved and to accommodate pole diameters from 3 inches to 14 inches, with a 1/2 inch diameter access hole for wiring at the rear of the housing. Cap the access hole with a plastic plug. Equip the housing at the front to allow for mounting of the front cover.

C. Supply the front cover in yellow (color number 595B-13538) cast aluminum. Provide a weather-tight seal between the housing and the cover using a neoprene gasket. Secure the cover, and the pushbutton switch to the housing, with stainless steel, vandal-resistant screws. .

D. Provide weatherproof and tamperproof, pushbutton switch(es) to be actuated by a 2 inch diameter mushroom plunger. Use a spring installed between the plunger and the switch that has an operating force of no more than 5 pounds. Provide a moisture barrier between the plunger and the switch and a two (2) position terminal block for termination of the #14 AWG pushbutton wire. Provide a pushbutton switch capable of operating in at temperature range of -30 degrees Fahrenheit to +165 degrees Fahrenheit and rated for up to 10,000,000 actuations. Provide the pushbutton switch electrically rated to carry 25 amps at 125 volts AC, 250 volts maximum.

E. The Department will furnish the sign for the pushbutton assembly to the Contractor for installation as shown in the Contract Documents.

F. Provide all Materials required to mount the pushbutton assembly in accordance with the Contract Documents.

SECTION 1076 – SPAN WIRE AND MESSENGER WIRE

1076.01 Material Requirements. Furnish all span wire, messenger wire and accessories new and free of defects. Use hardware meeting AASHTO M 232, Class C requirements, unless otherwise specified.

1076.01.1 Span Wire.

A. Span Wire, 7/16 inch: Use galvanized steel extra high-strength grade wire meeting ASTM A 475 and having a minimum of 7 wires, 7/16 inch in diameter and a minimum tensile strength of 20,800 pounds.

B. Span Wire, 1/4 inch: Use galvanized steel wire meeting ASTM A 475 requirements and having a minimum of 7 wires, 1/4 inch in diameter and a minimum strength of 6,650 pounds.

C. Span Wire Hardware:

1. Two service sleeves – to anchor the loose ends of the span wire.
2. Two strain insulators – minimum rated strength of 20,000 pounds.
3. Four galvanized guy clamps – six (6) inches in length, each complete with three 5/8 inch galvanized bolts and nuts, meeting AASHTO M 232, Class C, and suitable for use on 7/16 inch to 1/2 inch span wire.
4. Additional hardware may be required for span-to-span attachments, such as “H” span and “Suspended Box” span installations.

D. Additional Materials for Wood Pole Installation:

1. Four strain plates
2. 16 galvanized screws, 1/4 inch x 2-1/2 inches
3. Four guy hooks
4. Four 5/8 inch x 4 inches lag screws

1076.01.2 Dead End Messenger Wire Attachment.

A. Materials for Wood Pole Installation:

1. Galvanized eyebolt with a rod diameter of 3/4 inch and a length to suit the use intended with two galvanized nuts.
2. Two each, 3 inches x 3 inches x 1/4 inch galvanized washers with 13/16 inch hole.
3. Service wedge clamp.

B. Materials for Steel Pole Installation:

1. Two galvanized guy clamps 6 inches long with three 5/8 inch galvanized nuts and bolts.
2. A service sleeve to anchor the loose end of the messenger wire.

1076.01.3 Intermediate Messenger Wire Attachment.

A. Straight Run Intermediate Messenger Wire Attachment:

1. Depending on the size of the messenger wire, use a galvanized cable suspension clamp or a galvanized guy clamp. Use clamp that is 6 inches long with two outside holes suitable for 1/2 inch bolts and one center hole for a 5/8 inch machine bolt. Equip the clamp assembly to include two 1/2 inch galvanized nuts and bolts.
2. Galvanized machine bolt with a rod diameter of 5/8 inch and a length to suit the use intended with two galvanized nuts.
3. Guy hook.

4. 3 inches x 3 inches x 1/4 inch galvanized steel washer with 11/16 inch center hole.

B. Angular Run Intermediate Messenger Wire Attachment:

1. Two service wedge clamps.
2. Galvanized eyebolt with a rod diameter of 3/4 inch and a length to suit the use intended with two galvanized nuts.
3. Two 3 inches x 3 inches x 1/4 inch galvanized steel washers with 13/16 inch center hole.

1076.01.4 Grounding Equipment.

A. 3 feet of #6 AWG solid copper wire in accordance with Section 832.

B. #4 plated split-bolt connector (Blackburn #4 HPS)

C. Parallel groove connector (Blackburn #K2 Jumper Clamp)

SECTION 1077 – GUYS AND ANCHORS

1077.01 Material Requirements. Use hardware meeting AASHTO M 232, Class C requirements, unless otherwise specified.

1077.01.1 Down Guy and Anchor

A. Furnish stranded guy wire in accordance with Section 1076.01.1 and as specified in the Contract Documents.

B. Screw anchors with forged-eye anchor rods

1. Nominal rating of 8,000 pounds in average soil
2. 8 inch diameter
3. 2 inch pitch
4. 1 inch rod diameter
5. 5-1/2 inch rod length

C. Galvanized Guy clamps:

1. Suitable for 7/16 inch stranded guy wire
2. 6 inches in length
3. Three 5/8 inch galvanized nuts and bolts.

D. Galvanized Guy attachments:

1. Galvanized machine bolt: Rod diameter of 5/8 inch minimum, length to suit the pole it is to be used on.
2. Full round and half round guy wire protector: 7 feet in length, yellow plastic material
3. Flat washer 3 inch x 3 inch x 1/4 inch with an 11/16 inch hole for 5/8 inch bolt or flat washer 3 inch x 3 inch x 1/4 inch with a 13/16 inch hole for ¾ inch bolt, as appropriate.

E. Sidewalk guy fittings

F. Pipe for sidewalk guys

G. #6 AWG Solid Bare Copper Ground Wire in accordance with Section 832.

H. Two parallel groove connectors: Blackburn #K2 – jumper clamp, Ilsco or approved equal

I. #4 plated split bolt connector: Blackburn #4HPS, Thomas and Betts and Burndy or approved equal

J. Strain insulator, minimum rated strength of 20,000 pounds

1077.01.2 Overhead Guy

A. Furnish stranded guy wire in accordance with Section 1076.01.1 and as specified in the Contract Documents.

B. Galvanized thimbleye bolts or machine bolts and galvanized thimbleye nuts.

C. Galvanized square washers

D. Galvanized square nuts

E. Strain insulator, minimum rated strength of 20,000 pounds

F. Galvanized guy clamps:

1. 6 inches in length

2. Complete with three 5/8 inch galvanized bolts and nuts, suitable for use on 1/4 inch to 1/2 inch guy wire

G. For each end of the overhead guy:

1. #6 AWG Solid Bare Copper Wire, 3 feet in length in accordance with Section 832.

2. Two parallel groove connectors: Blackburn #K2 – jumper clamp, Ilsco or approved equal

SECTION 1078 – SERVICE PEDESTALS AND SAFETY SWITCH

1078.01 Materials Requirement.

A. Pedestal Board

1. Aluminum or Galvanized Steel
2. Minimum 1/4 inch thickness

B. Weather Proof Stamp

C. Single Position Sockets

1. Milbank U7040-RL-TG or U4532-XL; Cutler Hammer or approved equal.

D. Fusible or Non-Fusible Heavy Duty Safety Switch

1. See Plans for voltage and current rating.
2. NEMA 3R enclosure, Square D, Eaton; or approved equal.

E. #4 split bolt connector

1. Burndy #KSU20, Blackburn; or approved equal

F. Pressed steel channel clevis

1. Blackburn #W62, Burndy; or approved equal

G. Insulator

H. Circuit Breakers, molded case type

1. Minimum rating of 10,000 amp interrupting capacity (AIC)
2. Quick make, quick break, thermal magnetic, trip indicating, and have common trip on all multiple breakers with internal tie mechanism
3. Furnish circuit breakers with the current and voltage ratings and number of poles as specified in the Contract Documents.
4. Treated to resist fungus
5. Ambiently compensated for the enclosure and proximity to adjacent breakers.
6. Bolt in type.

I. Photoelectric Controls

1. Solid state, cadmium sulfide type with hermetically sealed silicone rectifier rated 120 Volts, 60 cycle AC and 1000 watts maximum load.
2. Equip with built in surge protection.
3. Equip with a fail-safe operating feature so that the lighting circuits will remain energized in the event the photo control components become inoperative.
4. Nominal operating levels of this control shall turn on at a minimum vertical illumination value of 3 foot-candles and turn off at a maximum vertical illumination value of 6 foot-candles.
    a. Have the manufacturer set these limitations; and tolerances of plus or minus 20 percent for the specified value will be acceptable.
5. Equip with twist lock type photoelectric controls for luminaires and lighting controls.
6. Supply with a suitable mounting bracket with locking type receptacle and all other necessary mounting hardware.

J. Contactors and Relays

1. Provide Contactors of the current ratings and number of poles specified in the Contract Documents.
    a. Fully rated for all classes of load to 600 Volts
    b. Has an interrupting rating of 600 percent of rated current.
2. Provide a HAND-OFF-AUTOMATIC selector switch in the photoelectric cell circuit.
3. Provide relays of the type, size, and contact ratings as specified in the Contract Documents.

K. Panel Boards

1. Federal Specification W-P-115
2. Suitable for operation on the voltage and type service specified.
3. UL listed and labeled
4. Equipped with the number and size circuit breakers specified
5. Furnish circuit breakers in panel boards that meet requirements in Federal Specification W-C-375 and bolt to copper busses.
6. Buss ratings shall be as specified.

L. Lightning Arresters.

1. Secondary type, having the specified number of poles and 0 to 650 Volts RMS.
2. Provided with suitable mounting brackets and all other necessary mounting hardware.

M. Control Power Transformers

1. Dry type, two windings, of the size and voltage ratings specified in the Contract Documents.

N. Enclosures

1. Meet the NEMA type specified
2. Dead front type weatherproof metal enclosed self-supporting structures, as specified in the Contract Documents.
3. Free standing enclosures
    a. Fabricated from sheet aluminum and be as specified herein.
        i. Use panel and control equipment cabinets in accordance with the manufacturer's standard enclosure for the type and application specified
        ii. Door clamps, solid neoprene gaskets, welded seams, stainless steel external hardware, and continuous hinges with stainless steel pins.
        iii. Two weep holes in the bottom and shall be equipped for padlocking.
4. Pad Mounted Enclosures
    a. For ventilation, provide all cabinets with louvered vents in the front door with a removable air filter.
    b. Provide louvers that meet the NEMA Rod Entry Test for 3R rated ventilated enclosure.
    c. Use filters for all cabinets with the dimensions of 16 in. long, 12 in. wide and 1 in. thick.
        i. Install the filter so that it covers the vents and is held firmly in place with top and bottom brackets and a spring loaded upper clamp.
        ii. Vent exhaust air out of the cabinet between the top of the cabinet and the main access door.

iii. Screen the exhaust area with a Material having a maximum hole diameter of 1/8 in.

O. Thermostats and Fans

1. Provide a thermostatically controlled cooling fan for all cabinets, rated for 125 percent of capacity.
2. Mount fan at the top of the cabinet.
3. Use only thermostats of the inline type, single pole, 120 Volts, 10 amps with a minimum range of 40 to 80 Fahrenheit.
4. Use a fan with a minimum rated capacity of 100 CFM air flow and a minimum rated design life of 100,000 hours.
5. Provide a thermostat that is manually adjustable, within a 10 degree range, from 70 to 160 Fahrenheit.

P. Disconnect Switches and Utility Connections

1. NEMA standard KS 1, latest edition.
2. Use only a Type 4 stainless steel enclosure, with external operating handle, enclosure cover interlock, and external switch mechanism handle with provisions for securing in both the ON and OFF positions by padlock.
3. Use a switch mechanism that is of heavy duty design with quick make, quick break type operations, and visible blades.
4. Use a disconnect switch on the line side that is fusible with integral fuse puller.
5. Use a non-fusible disconnect switch on the load side.
6. Furnish single phase disconnect switches that have 2 poles with a solid neutral and rated at 240 Volts.
7. Furnish three phase disconnect switches that have 3 poles with a solid neutral and rated at 600 Volts.
8. The design of the neutral bar may be factory or field installable.
9. Use single phase 60 amps (fused 35 amps) for disconnect switch fuseholders for traffic signals, intersection control beacons, and intersection lighting operating at 120 Volts.
10. Use single phase 30 amps (fused 20 amps) for disconnect switch fuseholders for hazard identification beacons and luminaires mounted on traffic signal Structures operating at 120 Volts.
11. Equip disconnect switches for lighting control cabinets with the same number of poles and amperage rating specified in the electrical service equipment item.
12. Equip disconnect switches for electrical service distribution cabinets with 200 amp, 2 pole, and single phase.

SECTION 1079 – LOOP DETECTOR

1079.01 Material Requirements.

A. 1-conductor #14 AWG Cable in 1/4 inch Flexible Tubing – consists of cable preinstalled in a polyethylene (PE) plastic duct meeting IMSA 51-5, rated for 600 volts. Use a cable with a temperature tolerance range of at least -65 to 176 degrees Fahrenheit. The conductor is AWG #14 stranded copper. Outside diameter of the cable is 0.25 inches. Referred to as “loop wire”.

B. Flexible embedding sealer – A two-component polyester loop sealant that is highly durable and remains permanently flexible. Use a loop sealant capable to withstand the corrosive effect of road salts, automotive fluids, jet fuel, gasoline and extreme weather conditions. Minimize the length a lane is closed using a loop sealant that features rapid chemical curing and has extreme adhesion to concrete and asphalt. A sealer accelerant or retarder may be added per the manufacturer’s specifications.

SECTION 1080 – LIGHTING CONTROL CABINETS

1080.01 Cabinet Enclosure.

A. Dead front type weatherproof metal enclosed self-supporting structure

B. Enclosure is rated NEMA 4X

C. Enclosure has door clamps, solid neoprene gaskets, welded seams, stainless steel external hardware and continuous hinges with stainless steel pins.

D. Provide all cabinets with louvered vents in the front door with a removable air filter.

1. Louvers satisfy the NEMA Rod Entry Test for 4X rated ventilated enclosure.

2. Filters are 16inch long, 12 inch wide, and 1 inch thick.

    a. Filter covers vents, and is held firmly in place with top and bottom brackets and a spring loaded upper clamp.

3. Exhaust air is vented out of the cabinet between the top of the cabinet and the main access door.

    a. Exhaust area is screened with a screen type material having a maximum hole diameter of 1/8 inch.

E. Install two weep holes at the bottom.

F. Equip enclosure for padlocking.

1080.02 Circuit Breakers.

A. Breakers are commercial grade bolt-in type.

B. Conforms to Federal Specification W-C-375.

C. Molded case type with minimum rating of 22,000 amp interrupting capacity (AIC)

D. Quick make, quick break, thermal magnetic, trip indicating

E. Breakers are Multi-Pole, with internal tie mechanism to provide means of simultaneous trip.

1. Use of Single Pole breakers with handle ties is prohibited.

F. Breakers have current and voltage ratings, with number of poles as specified on the Plans.

G. Breakers are capable of accepting up to a #2 AWG conductor.

H. Treat breakers to resist fungus and be ambiently compensated for the enclosure and proximity to adjacent breakers.

I. Provide a minimum of 2 spare circuit breakers.

1080.03 Photoelectric Control.

A. Shall be solid state, cadmium sulfide type with hermetically sealed silicone rectifier

B. Rated at 120/240 or 277 volts, 60 cycle AC, 1,000 watts maximum load, with built in surge protection

C. Failsafe operating feature so that lighting circuits remain energized in event the photo control components become inoperative.

D. Nominal operating levels turn on at a minimum vertical illumination value of 3 fc (32 lux) and turn off at a maximum vertical illumination value of 6 fc (65 lux).

1. These limitations are set by the manufacturer, and tolerances of plus or minus 20 percent are acceptable.

E. Photoelectric Control is twist lock type.

1. Furnish suitable mounting bracket with locking type receptacle and all other necessary mounting hardware.

1080.04 Contactors and Relays.

A. Contactors are held by permanent magnets.

B. Fully rated for all classes of load to 600 volts AC, with interrupting rating of 600 percent of rated current.

C. Provide a HAND-OFF-AUTOMATIC selector switch in the photoelectric cell circuit.

D. Relays are of type, size and contact ratings as specified in the Contract Documents.

1080.05 Panel boards.

A. Conforms UL listed.

B. Panel board has a minimum of 12 spaces for branch circuit breakers.

C. Suitable for operating voltage as specified in the Contract Documents.

D. Equipped with the number and size circuit breakers as specified in the Contract Documents.

E. Circuit breakers are bolted to copper busses.

1. Buss ratings are as specified in the Contract Documents.

F. Provide Transient Voltage Surge Suppressors (TVSS).

1080.06 Lightning Arresters.

A. Arresters are secondary type, with 0-650 volts RMS, and number of poles as specified in the Contract Documents.

B. Provide suitable mounting brackets and all other necessary mounting hardware for Arresters.

1080.07 Fans and Combination Thermostat/Humidistat.

A. Provide a thermostatically controlled cooling fan, rated at 125 of capacity, for all cabinets.

B. Mounted inside, at the top of the cabinet, as specified in the Contract Documents.

C. For single phase cabinets, thermostat/humidistat is inline type, single pole, with an operating voltage is 120 VAC, rated at 10 amps, with a minimum range of 70F to 160F.

1. Fan has operating voltage of 120 VAC, with minimum rated capacity of 100 CFM air flow and minimum rated design life of 100,000 hours.

D. For three phase cabinets, thermostat/humidistat is inline type, three pole, with an operating voltage is 480 VAC, rated at 10 amps, with a minimum range of 70F to 160F.

1. Fan has operating voltage of 480 VAC, with minimum rated capacity of 100 CFM air flow and minimum rated design life of 100,000 hours.