Standard Specifications

for

Road and Bridge Construction

JANUARY - 2025



Prepared by

The State of Delaware

DEPARTMENT OF TRANSPORTATION

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

Nicole Majeski, Secretary
Shanté A. Hastings, Chief Engineer

TABLE OF CONTENTS

PAGE

DIVISION 100 — GENERAL PROVISIONS 1
SECTION 101 — GENERAL INFORMATION, DEFINITIONS, AND TERMS 1
101.1 General. 1
101.2 Abbreviations. 1
101.3 Definitions. 3
101.4 Units of Measure 8
SECTION 102 — BIDDING REQUIREMENTS AND CONDITIONS 10
102.1 Bidder Registration. 10
102.2 Bid Proposal Contents. 10
102.3 Bid Proposal Issuance. 10
102.4 Interpretation of Quantities in the Bid Proposal Form. 11
102.5 Examination of Plans, Specifications, Bid Proposal, and Site of Work 11
102.6 Proposal Preparation. 12
102.7 Irregular Proposals. 12
102.8 Proposal Guaranty. 13
102.9 Proposal Delivery. 13
102.10 Proposal Withdrawals or Revisions 14
102.11 Public Opening of Proposals. 14
102.12 Bidder Disqualification. 14
102.13 Proposal Rejection. 14
102.14 Materials Guaranty. 15
102.15 Non-Collusive Bidding Certification. 15
SECTION 103 — AWARD AND EXECUTION OF THE CONTRACT; BID DOCUMENT ESCROW 16
103.1 Bid Consideration. 16
103.2 Contract Award. 16
103.3 Award Cancellation. 16
103.4 Proposal Security Return. 16
103.5 Performance and Payment Bonds. 16
103.6 Bid Withdrawal. 17
103.7 Contract Execution and Approval; Proof of Insurance. 17
103.8 Failure to Execute a Contract. 17
103.9 Escrow of Bid Documentation. 17
SECTION 104 — SCOPE OF WORK 20
104.1 Intent of the Contract. 20

TABLE OF CONTENTS

PAGE

104.2 Contract Changes. 20
104.3 Notification of Contract Changes. 23
104.4 Existing Signs. 24
104.5 Bus Stops. 24
104.6 Material Testing Certification. 24
104.7 Accident Notification. 25
104.8 Maintaining Traffic. 25
104.9 Rights In and Use of Materials Found in the Work. 25
104.10 Additional Utility Relocations Required by the Department; Restoration of Surfaces Opened by Permit. 25
104.11 Value Engineering Proposals. 26
104.12 Final Cleaning of Project Site; Maintenance and Cleanup of Staging Areas. 27
104.13 Contractor's Responsibility for the Work. 28
104.14 Required Notifications for Disturbing Property and Using Bridges. 28
104.15 E-Construction. 29
SECTION 105 — RESPONSIBILITIES OF THE DEPARTMENT; INTERPRETATION OF THE CONTRACT DOCUMENTS; MAINTENANCE DURING CONSTRUCTION; CLAIMS; PROJECT ACCEPTANCE 30
105.1 Authority of the engineer. 30
105.2 Authority and Duties of Inspectors. 31
105.3 Inspection of the Work. 31
105.4 Plans, Shop Drawings, and Working Drawings. 31
105.5 Conformity with the Plans and Specifications. 33
105.6 Coordination of the Contract Documents. 33
105.7 Contractor’s Supervision. 34
105.8 Cooperation Between Contractors. 34
105.9 Utilities within the Project Limits; Miss Utility One-Calls. 35
105.10 Construction Stakes, Lines, and Grades Provided by the Department. 36
105.11 Removal of Defective and Unauthorized Work. 36
105.12 Load Restrictions. 37
105.13 Maintenance During Construction. 38
105.14 Opening Sections of the Project to Traffic. 38
105.15 Claims Resolution. 39
105.16 Partial Acceptance; Project Acceptance; Final Acceptance; and Project Closeout. 49
SECTION 106 — MATERIAL QUALITY AND TESTING REQUIREMENTS 51
106.1 Source of Supply and Quality Requirements. 51

TABLE OF CONTENTS

PAGE

106.2 Samples, Tests, and Referenced Specifications. 51
106.3 Compliance Certification. 52
106.4 Manufacturing Plant Inspection. 52
106.5 Field Laboratory. 52
106.6 Storage and Handling. 52
106.7 Unacceptable Materials. 53
106.8 Disposal of Unacceptable Materials. 53
106.9 Department-Provided Material. 53
SECTION 107 — LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC 55
107.1 Laws to be Observed. 55
107.2 Permits, Licenses, and Taxes. 55
107.3 Patented Devices, Materials, and Processes. 55
107.4 Contractor's Responsibility to Protect Utility Property and Services. 55
107.5 Federal Aid Participation. 55
107.6 Construction Safety, Health, and Sanitary Standards. 56
107.7 Public Convenience and Safety. 56
107.8 Use of Explosives. 56
107.9 Protection and Restoration of Property. 57
107.10 Responsibility for Damage Claims. 57
107.11 Furnishing Right-Of-Way. 58
107.12 Personal Liability of Public Officials. 58
107.13 Contractor’s Responsibility for the Work after Final Acceptance; No Waiver of Legal Rights. 58
107.14 Hazardous Materials Discovered Within the Project Limits. 58
107.15 Audits. 59
SECTION 108 — SUBCONTRACTING; NTP; PROGRESS SCHEDULES; TIME EXTENSIONS; LIQUIDATED DAMAGES; TERMINATION 60
108.1 Contract Subletting. 60
108.2 Preconstruction Meeting; Submitting a Schedule; Notice to Proceed. 62
108.3 Commencement of Work; Counting Contract Time. 62
108.4 Progress Schedule. 62
108.5 Traffic Requirements and Contractor's Operations; Completing Work. 76
108.6 Preference for Delaware Labor; Character of Workers and Equipment; Specified Construction Methods. 76
108.7 Extensions of Contract Time. 77
108.8 Failure to Complete on Time. 80

TABLE OF CONTENTS

PAGE

108.9 Schedule of Liquidated Damages. 81
108.10 Default of the Contract. 82
108.11 Termination of the Contract for Convenience 83
108.12 Termination of the Contractor's Responsibility. 83
SECTION 109 — MEASUREMENT AND PAYMENT 85
109.1 Measurement of Quantities. 85
109.2 Scope of Payment for Unit Prices; Payment of Subcontractors. 86
109.3 Compensation for Altered Quantities. 86
109.4 Compensation for Changes. 87
109.5 Non-Allowable Charges. 94
109.6 Compensation for Delay. 95
109.7 Basis of Payment for Fixed Quantity Items. 96
109.8 Pay Estimates and Retainage. 97
109.9 Payment for Stored Material. 97
109.10 Withholding of Money Due on an Estimate to Offset a Contractor’s Liability. 99
109.11 Final Payment and Time Limit to Challenge Quantities. 99
109.12 Source of Supply and Carrier Rates on Construction Materials. 100
109.13 Transportation Tax Exemption. 100

DIVISION 200 — EARTHWORK 101
SECTION 201 — CLEARING AND GRUBBING 101
SECTION 202 — EXCAVATION AND EMBANKMENT 103
SECTION 203 — CHANNEL EXCAVATION 116
SECTION 204 — TEST HOLES 117
SECTION 207 — STRUCTURAL EXCAVATION AND BACKFILLING 118
SECTION 208 — FLOWABLE FILL 122
SECTION 209 — BORROW 124
SECTION 211 — REMOVAL OF STRUCTURES AND OBSTRUCTIONS 126

DIVISION 300 — BASE COURSES 128
SECTION 301 — GRADED AGGREGATE BASE COURSE 128
SECTION 302 — STONE 130

DIVISION 400 — BITUMINOUS MATERIALS 131
SECTION 401 — BITUMINOUS PAVEMENT 131
SECTION 403 — BITUMINOUS PAVEMENT MATERIALS FOR TEMPORARY ROADWAY MATERIAL 136

TABLE OF CONTENTS

PAGE

SECTION 404 — BITUMINOUS CRACK AND JOINT SEALING 137

DIVISION 500 — RIGID PAVEMENT 139
SECTION 501 — PORTLAND CEMENT CONCRETE PAVEMENT 139
SECTION 503 — PATCHING PORTLAND CEMENT CONCRETE PAVEMENT 151
SECTION 504 — PCC CRACK AND JOINT SEALING 158
SECTION 505 — PCC PATCHING, PARTIAL DEPTH 161

DIVISION 600 — STRUCTURES 163
SECTION 601 — PIPE CULVERTS 163
SECTION 602 — DRAINAGE STRUCTURES 175
SECTION 604 — TEMPORARY WORKS 181
SECTION 605 — DRIVEN PILES 188
SECTION 606 — DRILLED SHAFTS 203
SECTION 607 — EARTH RETAINING WALL SYSTEMS 223
SECTION 608 — PERMANENT SHEET PILES 227
SECTION 610 — CONCRETE STRUCTURES 229
SECTION 611 — CONCRETE REINFORCEMENT 249
SECTION 612 — PRECAST CONCRETE 253
SECTION 613 — CONCRETE COATINGS AND MEMBRANES 260
SECTION 614 – ULTRA HIGH-PERFORMANCE CONCRETE 264
SECTION 615 — STEEL STRUCTURES 267
SECTION 616 — STEEL COATINGS 284
SECTION 617 — STEEL SIGN STRUCTURES 306
SECTION 619 — STONE AND BRICK MASONRY 311
SECTION 621 — WOOD STRUCTURES 314
SECTION 623 — BEARING DEVICES 317
SECTION 624 — JOINTS 321
SECTION 625 — CONCRETE OVERLAYS 325
SECTION 626 — METAL RAILINGS 336
SECTION 628 — CONCRETE REPAIR AND REHABILITATION 338

DIVISION 700 — MISCELLANEOUS CONSTRUCTION 347
SECTION 701 — PCC CURB, INTEGRAL PCC CURB, PCC MONOLITHIC MEDIAN, AND CURB OPENINGS 347
SECTION 702 — TRIANGULAR CHANNELIZING ISLANDS 352

TABLE OF CONTENTS

PAGE

SECTION 705 — PCC SIDEWALK, PEDESTRIAN CONNECTIONS, AND DETECTABLE WARNING SURFACES 355
SECTION 706 — MONUMENT 361
SECTION 707 — RIPRAP 363
SECTION 708 — GEOTEXTILES 366
SECTION 709 — UNDERDRAINS 367
SECTION 710 — WATER SERVICES 370
SECTION 711 — SANITARY SEWER SYSTEM 383
SECTION 720 — GUARDRAIL 388
SECTION 721 — GUARDRAIL END SECTIONS AND TRANSITIONS 392
SECTION 722 — HIGH-TENSION CABLE BARRIER 397
SECTION 723 — CONCRETE BARRIER 403
SECTION 724 — IMPACT ATTENUATOR 406
SECTION 727 — FENCE 409
SECTION 760 — PAVEMENT MILLING AND RUMBLE STRIPS 416
SECTION 762 — SAW CUTTING AND BUTT JOINTS 418
SECTION 763 — INITIAL EXPENSE, DE-MOBILIZATION 420

DIVISION 800 — TRAFFIC 422
SECTION 801 — TEMPORARY TRAFFIC CONTROL — GENERAL 422
SECTION 802 — ARROW BOARDS 428
SECTION 803 — PORTABLE CHANGEABLE MESSAGE SIGN 430
SECTION 804 — PORTABLE LIGHT ASSEMBLY 432
SECTION 805 — PLASTIC TRAFFIC CONTROL DRUMS 434
SECTION 806 — TRAFFIC OFFICERS 436
SECTION 807 — TEMPORARY SAFETY BARRIER 438
SECTION 808 — TRUCK MOUNTED ATTENUATOR 443
SECTION 809 — TEMPORARY IMPACT ATTENUATOR 446
SECTION 810 — TEMPORARY WARNING SIGNS 449
SECTION 811 — FLAGGERS 452
SECTION 812 — CERTIFIED TRAFFIC CONTROL SUPERVISOR 453
SECTION 813 — TEMPORARY BARRICADES 454
SECTION 818 — SIGN PANELS 457
SECTION 819 — SIGN POSTS 462
SECTION 820 — BREAKAWAY I-BEAM SIGNS 465
SECTION 821 — BARRIER-MOUNTED SIGNS 468

TABLE OF CONTENTS

PAGE

SECTION 822 — OVERHEAD AND CANTILEVER SIGN PANELS 470
SECTION 823 — SPAN WIRE AND MAST ARM SIGN PANELS 472
SECTION 824 — DELINEATORS 474
SECTION 826 — PERMANENT WOOD BARRICADE 476
SECTION 830 — CONDUIT JUNCTION WELLS 477
SECTION 831 — CONDUIT 481
SECTION 832 — ELECTRIC AND ITMS CABLE AND SPLICING 487
SECTION 833 — GROUNDING 494
SECTION 834 — POLE BASES, EXTENSIONS, AND SHEETING 496
SECTION 835 — CABINET BASES 500
SECTION 836 — TRAFFIC SIGNAL POLES AND MAST ARMS 502
SECTION 837 — TRAFFIC SIGNAL INDICATIONS 504
SECTION 838 — SPAN WIRE AND MESSENGER WIRE 509
SECTION 839 — WOOD POLES 514
SECTION 840 — DOWN GUYS AND ANCHORS 516
SECTION 841 — WEATHERHEADS 518
SECTION 842 — SERVICE PEDESTAL AND SAFETY SWITCH 519
SECTION 843 — HIGHWAY LIGHTING ELECTRICAL TESTING 522
SECTION 844 — EMERGENCY PREEMPTION DETECTOR 527
SECTION 846 — LOOP DETECTOR 529
SECTION 847 — LIGHTING CONTROL CABINETS 532
SECTION 850 — LUMINAIRE 534
SECTION 851 — ALUMINUM LIGHTING STANDARD 539
SECTION 860 – LATEX PAVEMENT MARKINGS 542
SECTION 861 – EPOXY PAVEMENT MARKINGS 547
SECTION 862 – ALKYD TYPE THERMOPLASTIC PAVEMENT MARKINGS 551
SECTION 863 – PREFORMED THERMOPLASTIC PAVEMENT MARKINGS 556
SECTION 864 – PREFORMED PAVEMENT MARKING TAPE 559
SECTION 865 – TEMPORARY PAVEMENT MARKING TAPE 564
SECTION 866 – BLACKOUT PAVEMENT MARKING TAPE 567
SECTION 867 – SNOWPLOWABLE RAISED PAVEMENT MARKERS 569
SECTION 868 – PAVEMENT MARKING REMOVAL 571

DIVISION 900 — EROSION, SEDIMENT, AND STORMWATER MEASURES 573
SECTION 901 — EROSION, SEDIMENT, AND STORMWATER MANAGEMENT 573

TABLE OF CONTENTS

PAGE

SECTION 902 — PUMPING OR DEWATERING OPERATIONS 576
SECTION 903 — POLLUTION PREVENTION 579
SECTION 905 — SEDIMENT TRAPPING DEVICES 580
SECTION 906 — DEWATERING PRACTICES 585
SECTION 907 — WATER CONTROL PRACTICES 590
SECTION 908 — SOIL STABILIZATION PRACTICES 594
SECTION 909 — WATERWAY CONSTRUCTION PRACTICES 604
SECTION 910 — STORMWATER MANAGEMENT FACILITIES 612
SECTION 911 — PLANTINGS 620

DIVISION 1000 — MATERIALS 629
SECTION 1001 — BORROW 630
SECTION 1002 — CLAY BORROW 631
SECTION 1003 — FINE AGGREGATE 632
SECTION 1004 — COARSE AGGREGATE 633
SECTION 1005 — GRADED AGGREGATES 635
SECTION 1006 — STONE 636
SECTION 1010 — RELEASE AGENTS 637
SECTION 1011 — TACK COAT 638
SECTION 1012 — ASPHALT CEMENT 639
SECTION 1013 — ANTI-STRIPPING ADDITIVES 640
SECTION 1014 — ASPHALT MATERIALS PRODUCTION 641
SECTION 1015 — COLD PATCH 649
SECTION 1016 — EMULSIFIED ASPHALT 652
SECTION 1020 — CEMENT AND POZZOLANIC MATERIALS 653
SECTION 1021 — WATER FOR PORTLAND CEMENT CONCRETE 654
SECTION 1022 — PORTLAND CEMENT CONCRETE PRODUCTION 655
SECTION 1023 — PORTLAND CEMENT CONCRETE PATCHING MATERIAL 666
SECTION 1024 – CONCRETE ADHESIVES 667
SECTION 1025 – ULTRA HIGH-PERFORMANCE CONCRETE 669
SECTION 1030 — BAGGED RIPRAP 671
SECTION 1031 — PIPE CULVERTS 672
SECTION 1032 — PILE MATERIALS 674
SECTION 1033 — ACCESS TUBES FOR CROSSHOLE SONIC LOG TESTING 678
SECTION 1034 — CASINGS 679

TABLE OF CONTENTS

PAGE

SECTION 1035 — SLURRY 680
SECTION 1037 — EMBEDDED REINFORCEMENT AND HARDWARE 682
SECTION 1038 — PRESTRESSING STRANDS 683
SECTION 1039 — STRUCTURAL STEEL 684
SECTION 1040 — MASONRY UNITS 690
SECTION 1041 — WOOD 691
SECTION 1042 — JOINT/CRACK SEALANT MATERIAL 694
SECTION 1043 — JOINT BACKUP MATERIAL 695
SECTION 1044 — ALUMINUM FOR STRUCTURES 696
SECTION 1045 — CONCRETE COATINGS AND MEMBRANES 697
SECTION 1046 — CONCRETE OVERLAY MATERIALS 701
SECTION 1047 — GROUT AND FLOWABLE FILL 706
SECTION 1048 — MECHANICALLY STABILIZED EARTH WALL MATERIALS 708
SECTION 1049 — MISCELLANEOUS ITEMS FOR CONCRETE WORK 712
SECTION 1060 — GEOTEXTILE 713
SECTION 1061 — FENCE 715
SECTION 1062 — CONDUIT 722
SECTION 1070 — GUARDRAIL 724
SECTION 1071 — PAVEMENT MARKINGS 725
SECTION 1072 — SIGN POSTS 735
SECTION 1073 — DELINEATORS 738
SECTION 1074 — ELECTRICAL CABLE AND SPLICING 740
SECTION 1075 — TRAFFIC SIGNAL HEADS 744
SECTION 1076 — SPAN WIRE AND MESSENGER WIRE 753
SECTION 1077 — GUYS AND ANCHORS 755
SECTION 1078 — SERVICE PEDESTALS AND SAFETY SWITCH 757
SECTION 1079 — LOOP DETECTOR 761
SECTION 1080 — LIGHTING CONTROL CABINETS 762

LIST OF TABLES 765

DIVISION 100 — GENERAL PROVISIONS

SECTION 101 — GENERAL INFORMATION, DEFINITIONS, AND TERMS

101.1 General.

A. Active Voice, Imperative Mood.

1. These specifications are written in the active voice and the imperative mood.
2. In an active voice sentence, the subject of the sentence acts on something. For example: "The engineer will take a sample." A similar sentence in the passive voice – “A sample will be taken" – does not identify the party responsible for taking the sample.
3. The imperative mood is used for instructions to the contractor. For example, in an imperative sentence such as, "Pour the concrete," it is understood that the contractor is to pour the concrete.
4. Before contract award, requirements written in the imperative mood are directed to the contractors bidding the work. After award, requirements written in the imperative mood are directed to the contractor performing the work.

B. Titles and Headings, References, and Usage.

1. Titles and headings are intended for reference only and do not bear on the interpretation of the specifications that follow.
2. When the Department specifies a publication, the most recent issue of the publication before the date of advertisement governs, unless otherwise specified.
3. The word "will" applies to the decisions, actions, or responsibilities of the Department.
4. The word "shall" applies to the obligations of the contractor.
5. 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.
6. The words "or equal," referring to a product, material, or process, means "equal as determined by the engineer."
7. The specifications may present numerical values in 1 of 2 systems, U.S. customary units (English) or metric units. Use the numerical value specified in the contract.

101.2 Abbreviations.

AA	Aluminum Association
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute

ADA	Americans with Disabilities Act
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
ASR	Alkali-Silica Reaction
ASTM	American Society of Testing and Materials
ATSSA	American Traffic Safety Services Association
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
CFR	Code of Federal Regulations
DE MUTCD	Delaware (DE) Manual on Uniform Traffic Control Devices for Streets and Highways
DNREC	Delaware Department of Natural Resources and Environment
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards
GABC	Graded Aggregate Base Course
IEEE	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
JMF	Job Mix Formula
LOC	Limits of Construction
MSE	Mechanically Stabilized Earth
MASH	Manual for Assessing Safety Hardware
MIL-Spec	Military Specifications
MSDS	Material Safety Data Sheets

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
NRMCA	National Ready Mixed Concrete Association
OSHA	Occupational Safety and Health Administration or Act
PCA	Portland Cement Association
PCC	Portland Cement Concrete
PCI	Prestressed Concrete Institute
PTI	Post Tensioning Institute
PVC	Polyvinyl Chloride
SAE	Society of Automotive Engineers
SCE	Stabilized Construction Entrance
SSPC	Steel Structures Painting Council
TRM	Temporary Roadway Material
TTC	Delaware Manual on Uniform Traffic Control, Part 6, Temporary Traffic Control
USACOE	United States Army Corps of Engineers
UL	Underwriters Laboratory, Incorporated

101.3 Definitions.

Addendum, Addenda. Bid proposal revision or revisions issued after advertisement and before the bid opening date.
Additional Work. Work already provided for by the contract and for which the contract has established a pay item.
Adjustment. An increase or decrease in the contract price or contract time determined in accordance with Sections 109.4, Compensation for Changes, or 108.7, Extensions of Contract Time, respectively.
Advertisement. A public announcement inviting proposals for the work to be performed or material to be furnished.
Award. Department acceptance of a proposal before executing a contract.
Bidder. An individual or legal entity submitting a proposal.
Bid Documentation. Documentation related to the bidder's proposal not including documents provided by the Department for the bid proposal.
Bid Proposal. The Department's specific invitation to bid. It consists of the following documents and any referenced documents: the general description; general notices; special provisions, including utility, right of way, environmental, and railroad statements; plans, addendums, questions and answers, and any appendices or attachments; and the bid proposal form.
Bid Proposal Form. 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 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 having a minimum vertical opening of 4 feet.
Bridge Substructure. The structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, including backwalls and wingwalls.
Bridge Superstructure. The approach slabs and the entire structure above the substructure.
Business Day. Every day shown on the calendar, except Saturdays, Sundays, and defined holidays.
Calendar Day. Every day shown on the calendar, beginning and ending at midnight.
Change Order. A written order issued by the Engineer to modify the contract price or time or both. 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 otherwise 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, Claims Resolution, for the definition of claim.
Completion. 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. The complete body of documents pertaining to a specific project provided, or referenced, by the Department. These include:

1. the advertisement
2. the contract form
3. the contractor’s proposal
4. the Department’s bid proposal
5. performance, payment, and other bonds or guaranties
6. the specifications
7. the working drawings
8. the project plans
9. all required notices with respect to any of the following:
    a. change orders
    b. supplemental agreements
    c. all documents incorporated into the contract by reference
    d. the engineer's written directives.

Contract Payment and Performance Bonds. A payment bond is a guarantee that a contractor’s material and service suppliers and subcontractors on the project will be paid. A performance bond is a guarantee that the project will be satisfactorily completed in the event of a default or termination of a contractor.
Contract Time. The number of working days or calendar days provided in the contract for substantial completion of the project.
Contractor. The individual or legal entity contracting with the Department for performance of the work.
Culvert. 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 the Department’s bridge inventory.

Day. Calendar day.
Department (or DelDOT). The Delaware Department of Transportation.
Differing Site Conditions. Subsurface or latent physical conditions encountered at the site that differ materially or unknown physical conditions of an unusual nature from those indicated in the contract and are not generally recognized as inherent in the work provided for in the contract.
District. The subdivision of the Department that administers the contract.
District Engineer. The district engineer is the Department head of the district administering the contract.
Embankment. A structure constructed of material meeting the requirements of Section 209, Borrow, as described in Section 202, Excavation and Embankment.
Engineer. 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. 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. Work not required by the contract but determined by the Engineer to be essential to the satisfactory completion of the contract.
Falsework. Temporary construction intended to support permanent construction of a structural element until the element is self-supporting.
Final Acceptance. The work is substantially complete with all corrective work completed. The contractor is relieved of maintenance responsibilities as of the date of final acceptance.
Force Account. Work performed by the contractor at the engineer's direction.
Formwork. A temporary structure or mold used to retain and resist the operations of placing a plastic or fluid material in a designated shape until the material hardens.
General Description. 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. Federal and State of Delaware regulations contained in the bid proposal.

Holidays.

1. New Year's Day
2. Martin Luther King Jr. Day
3. Good Friday
4. Memorial Day
5. Juneteenth
6. Independence Day
7. Labor Day
8. General election day (biennial)
9. Return Day (Sussex County only after 12:00 noon)
10. Veteran's Day

11. Thanksgiving Day
12. Friday after Thanksgiving
13. Christmas Day
14. If a holiday falls on a Sunday, the Monday following will be a non-working day. If a holiday falls on a Saturday, the Friday preceding will be the non-working day. If any additional days are designated as legal holidays for State employees, by executive order of the Governor, and the contractor chooses to honor the days by not working, the Department will extend the contract time accordingly.
15. Obtain approval from the engineer 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 the holiday.
16. Additional time restrictions may apply for special events as noted in the contract.

Inspector. An authorized representative of the engineer.

Invitation for Bids. The invitation for bids is the advertisement of bid proposals.

Item Number Identification: Six digit pay item to be interpreted in accordance with the following:

1. Standard - The first 3 digits indicates the division and section number as described in the standard specifications, and all applicable requirements of that section. The last 3 digits identifies the pay item with a range from 000 to 499.
2. Special provisions - The first 3 digits indicates the division and section number as described in the standard specifications that are modified. The last 3 digits identifies the pay item with a range from 500 to 999.

Limits of Construction (LOC). The boundaries that define the area within which the contractor must confine its work.

Liquidated Damages. An amount due and payable to the Department by the contractor if the contractor fails to complete the project within the contract time.

Major Pay items. A pay item with a bid value that equals or exceeds 10 percent of the total contract bid price.

Materials. Any permanent substances, used in the construction of the project.

Materially Unbalanced Bid. A mathematically unbalanced bid that, if awarded, would not result in the lowest ultimate cost to the Department.

Mathematically Unbalanced Bid. A proposal containing pay items that do not include reasonable labor, equipment, and material costs plus a reasonable proportionate share of the bidder's overhead costs, other indirect costs, and anticipated profit.

Notice of Award. The written notice to the successful bidder stating that the Department accepts the bidder's proposal.

Notice to Proceed (NTP). A written notice to the contractor to begin work specifying when the Department will start the contract time.

OSHA. Occupational Safety and Health Act or Administration, depending on the context.

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

1. Subgrade. The top surface of the roadbed upon which the pavement structure is constructed.

2. Subbase. One or more layers of specified material thickness placed on a subgrade to support a base course (or in the case of rigid pavement, the PCC slab).
3. Base course. 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.
4. Surface course. 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."

Pay Item. A specific item of work priced in the bid proposal form.
Plans. The contract drawings that graphically show the work a contractor shall perform on a specific project.
Primary inspection. The inspection (formerly referred to as Final Inspection) conducted by the engineer to determine if the contractor has satisfactorily completed the project, or a portion of the project, in accordance with the contract.
Profile Grade line. Usually the centerline, and elevation to which the roadway or structure is to be built.
Project. The physical location of work and the work designed to take place at the location(s) in accordance with the contract.
Project Schedule. The contractor's detailed plan for performing the contract work within the contract time that includes work activities, dates for starting and finishing the activities, and durations for performing the work.
Proposal (Bid). 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. When not used in the context of bidding a proposal is a written offer provided to the engineer for consideration.
Proposal Guaranty. Security furnished with a proposal.
Responsive Bid. A bid that complies with all requirements of the bid proposal.
Responsible Bidder. A bidder that possesses the required knowledge and resources to perform the work that has not been disqualified or debarred.
Right-Of-Way. Land, property, or an interest therein possessed by the Department or other entity acquired for, or devoted to, transportation purposes. Rights-of-way identified in the contract are presumed to belong to the Department unless the contract identifies such rights-of-way as belonging to another entity.
Schedule of Items. The list of pay items of work contained in the bid proposal.
Secretary. The secretary of the Department of Transportation of the State of Delaware.
Shop Drawings. Contractor drawings that provide details for fabricating or constructing an element of work to be permanently incorporated into the project.
Special Events. Events that may impact the State of Delaware roadways.
Specifications. Written contract provisions and requirements for performing the work.

1. Standard specifications are the Department's publication Standard Specifications for Road and Bridge Construction that contains the Department's requirements and specifications for general application and repetitive use.
2. Special provisions are project specifications that are modifications of standard specifications, or are new specifications, that are requirements particular only to a specific project. These are provided in bid proposals.

Specialty items. Pay items that require highly specialized knowledge, abilities, or equipment to perform and that are not ordinarily specified by the Department.

Standard Construction Details. A DelDOT publication containing drawings of standard details of construction adopted by the Department for general application to miscellaneous items of work.
State. The State of Delaware.
Structures. Bridges, culverts, storm sewer appurtenances, retaining walls, sign support structures, buildings, and other similar items.
Subcontractor. An individual or legal entity contracting with the contractor, or another subcontractor, to perform work on the project.
Substantial Completion. The point at which the Department deems all contract items are complete excluding any warranties or vegetation growth.
Superintendent. The contractor's authorized responsible representative in charge of the work.
Supplemental Agreement. A written agreement signed by the Department and the contractor for performing work beyond the scope of the original contract that the Department elects to perform in conjunction with the existing contract.
Surety. The legal entity licensed to issue surety bonds in the State of Delaware by the Department of Insurance.
Unit Price. The price provided by the contractor in the proposal for a pay item.
Work. Work is the providing all labor, materials, equipment, services, and other incidentals necessary to complete the contract.
Working Day. Any day charged against the contract time on a working day contract.
Working Drawings. Drawings and data not in the contract that the contractor is required to submit to the engineer showing how the contractor will perform specific work such as building cofferdams or falsework.

101.4 Units of Measure.

Unless noted below, the engineer will make all measurements and determine all final item quantities to 2 places after the decimal point.

Abbreviation	Description	Measure
ACRE	acre	Two-dimensional area method on the surface to the nearest 0.1 acre.
BAG	bag	Item unit bag.
BF	board foot	Parallel to the longitudinal base or foundation upon which items are placed, or along the longitudinal surface of the item. Measured to 1/10-foot.
CF	cubic foot	Three-dimensional volume method measured to 1/100-foot.
CY	cubic yard	Three-dimensional volume method measured to 1/100-foot.
EA-DY	each day	Number of days of individual items of work completed.
EA-MO	each month	Number of months of individual items of work completed.
EA-NT	each night	Number of nights of individual items of work completed.
EACH	each	Number of individual items of work completed.
F	Fahrenheit	Degree of temperature. Measured to 1/10 of a degree.
GAL	gallon	Actual item liquid volume.
LF	linear foot	Parallel to the longitudinal base or foundation upon which items are placed, or along the longitudinal surface of the item. Measured to 1/10-

Abbreviation	Description	Measure
		foot.
LS	lump sum	Not measured. Indicates complete construction of the item of work, as specified.
LB	pound	Measured by actual item net weight, avoirdupois.
MFBM	thousand feet of board measure	1,000 feet board measured parallel to the longitudinal base or foundation upon which items are placed, or along the longitudinal surface of the item. Measured to 1/10-foot.
PCF	pounds per cubic foot	Pressure. Measured to 1/10-cubic foot.
PSI	pounds per square inch	Pressure. Measured to 1/10-square inch.
SF	square foot	Two-dimensional area method on the surface of the item.
SY	square yard	Two-dimensional area method on the surface of the item.
SY-IN	square yard - inch	Two-dimensional area method on the surface of the item per inch of depth.
TON	ton	Actual item net weight in short tons consisting of 2,000 pounds, avoirdupois.

SECTION 102 — BIDDING REQUIREMENTS AND CONDITIONS

102.1 Bidder Registration.

A. The Department requires bidders to register before submitting a proposal. Register by completing a registration form provided by the Department.

B. Upon receipt of the registration, the Department will list the prospective bidder on the Department's registry. Bidders must regularly update the Department with any changes to the information contained in the registry. Failure to provide current information may result in the loss of bidding privileges.

102.2 Bid Proposal Contents.

A. The bid proposal will contain the:

1. location and description of the work;
2. estimate of the various pay item quantities;
3. work the contractor shall perform;
4. materials the contractor shall furnish;
5. schedule of pay items for the bidders to price;
6. contract time;
7. amount of the required proposal guaranty; and
8. date, time, and place of the bid opening date.

B. The bid proposal will describe the type of bid award. The Department may base the bid award on total cost, low bid, or the type of contract such as A+B or best value. The bid proposal will include addenda, special provisions, and any other specifications or requirements that vary from, or are not contained in, the standard specifications.

C. The Department considers all papers bound with, or attached to, the bid proposal as 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.

102.3 Bid Proposal Issuance.

A. Contact the Department to receive the bid proposal in electronic format.

B. The Department will not provide printed bid proposals. The Department will post the bid proposal online on the State bid Solicitation Directory. The website bid proposal is not valid for submitting bids and the website documents are marked as such. The Department provides a printed set of plans and specifications for viewing in the bidder’s room at the DelDOT administration building in Dover. The Department will provide 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, Bidder Disqualification.

C. The Department will post all addenda online on the State’s bid solicitation directory. Addenda are included by reference in the bid proposal. Bidders are responsible for checking the website as needed to ensure that addenda are included in the bid proposal. The Department will post the

final addendum no later than the end of the day 2 business days before the bid opening date. Enter each addenda number and date on the submitted certification form.

102.4 Interpretation of Quantities in the Bid Proposal Form.

A. The quantities appearing in the bid proposal form are estimates used for the bid comparison. The Department will pay for the actual quantities of work performed and accepted or for materials provided in a contract for materials only. The Department reserves the right to increase, decrease, or eliminate estimated quantities of work and materials.

B. The Department will identify specialty items in the contract. If it is not so identified, then the item is not a specialty item. If a bidder believes that a pay item should be designated as a specialty item, submit a written request to designate the pay item as a specialty item to the Department at 6 business days prior to the bid opening date.

102.5 Examination of Plans, Specifications, Bid Proposal, and Site of Work.

A. Examine the site of the proposed work, the bid proposal, and all items designated and referenced in the bid proposal before submitting a proposal. Assume responsibility for all site conditions that may affect bid pricing that a site investigation would have revealed. Failure to examine the site before submitting a proposal will constitute a waiver of all rights to additional time or money related to conditions a site investigation would have revealed. The Department will consider submission of a proposal as conclusive evidence that the bidder examined the bid documents and the requirements of the proposed contract and is aware of, and accepts, the conditions the bidder may encounter in performing the work.

B. The Department will provide boring logs and other records of subsurface investigations for inspection by bidders if the Department has performed such investigations. Understand that the Department obtained and used subsurface investigation information for Department design and estimating purposes only. The Department will make all the subsurface information that the Department has available to bidders, for information only. Documentation designated “for information only” is not part of the contract. Do not rely on documents designated “for information only” for bidding a project.

C. The Department is not bound by any statements or representations concerning site conditions or descriptions of the work unless the statements or representations are included or designated in the bid proposal. Oral explanations or instructions given before the bid are not binding on the Department and the contractor shall not rely on oral explanations or instructions in preparing a bid.

D. If bidders have questions about the bid proposal, submit questions in writing to the Department’s e-mail address listed in the bid proposal no less than 6 business days before the bid opening date. The Department will post responses to bidder questions periodically on Delaware’s bid solicitation directory website. The Department will post the final questions and answers no later than the end of the day two business days before the bid date. Enter the final posted date on the submitted certification form. All questions and answers posted by the Department on the website, are included in the contract by reference. The Department will provide the successful, awarded bidder with a hard copy of the final posted questions and answers.

102.6 Proposal Preparation.

A. Submit the proposal as specified in the bid proposal. When using approved electronic media to submit bids, provide both the electronic copy and a hard copy of the bid unless otherwise specified in the proposal. Detach the bid proposal forms from the bid proposal. Specify a unit price in figures for each pay item that contains a quantity. Show the total cost of each pay item by multiplying the unit price by the quantity. Enter the bid prices using the provided electronic media. In case of a discrepancy between the electronically printed unit prices and the electronically printed bid amount, the Department will use the electronically printed unit price. 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.

B. Bidders may make last minute substitutions of unit prices on the bid proposal forms by striking a single line through the figure the bidders want to change and handwriting the new unit price, and the new bid item total price, in ink. Initial each handwritten substitution.

C. Acknowledge all bid proposal addenda on the certification form provided by the Department and submit the form with all required documents. A bidder's representative, authorized to execute proposals for the bidder, shall sign the proposal in ink. Include the name and the office address of the individual signing the proposal as well as the following names and office addresses as applicable in the proposal:

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

D. Bid proposals, bid proposal forms, and approved electronic media are serially numbered and are not transferable from one bidder to another. Unless otherwise provided in the proposal, the Department will not accept bids from joint ventures. Joint ventures may submit bids on bid proposals issued to the joint venture or to any one of the joint venture participants. Ensure that each member of the joint venture signs the bid proposal and follows each signature with the title "Joint Venturer."

102.7 Irregular Proposals.

A. The Department will consider proposals as irregular and will reject the proposals as non-responsive for any of the following reasons if the bidder:

1. Submits proposals on a form or computer-generated format that the Department has not approved.
2. Alters an approved form.
3. Detaches any part of the approved form.
4. Submits an incomplete form.

5. Includes unauthorized additions.
6. Handwrites between printed lines.
7. Adds bid conditions.
8. Includes proposal additions not anticipated or spelled out in the contract.
9. Provides an indefinite proposal by removing bidder commitments.
10. Adds wording or phrases that make the submittal appear unclear as to the intent of the bidder to follow the requirements.
11. Specifies a unit price of zero or fails to provide a unit price for every bid item indicated.
12. Submits a proposal with a unit price or proposal price using more than 2 decimals showing fractions of one penny.
13. Did not provide the bid documentation in a sealed container.
14. Submits a materially or mathematically unbalanced proposal.
15. Provides any handwritten substitutions of any unit prices that are not readable or are not initialed by the bidder.
16. Fails to provide a proposal guaranty.
17. Fails to sign the non-collusive bidding certification.
18. Fails to provide a proposal that complies with any other material requirements of the invitation for bids.

B. The Department will consider bids non-responsive if the bidder fails to:

1. Provide DBE information at the time of bid;
2. present written and notarized assurance that the bidder will meet the contract DBE goals; and
3. present written copies of all DBE bid commitments within the required number of calendar days after the bid opening date; or
4. include good faith effort documentation in proposals where the bidder does not meet the proposal DBE requirement.

102.8 Proposal Guaranty.

A. Provide either a bid bond from a corporate surety authorized to do business in Delaware or some form of financial security the bidder assigns to the Department. Bid securities include certified checks, cashier's checks, treasurer's checks, or other negotiable or transferable instruments evidencing an unconditional debt to the State or Department. Use the Department provided bond form. Provide a proposal guaranty equal to 10 percent of the total bid price. The bid bond does not need to cite a specific sum of money but does need to state that the bond equals 10 percent of the total bid price.

102.9 Proposal Delivery.

Take appropriate measures to submit a bid.

1. Place proposals in a sealed envelope and mark the envelope to indicate its contents by including the contract number and the bidder’s name and address. Deliver proposals before the bid

deadline, and to the location specified, in the advertisement. The Department will return a bid received after the specified bid deadline unopened to the bidder. Deliver proposals to: Contract Administration, DelDOT Administration Building, 800 Bay Road, Dover DE, 19901.

2. Use the electronic proposal form in the Department's bidding system.

102.10 Proposal Withdrawals or Revisions.

A. Bidders may withdraw or revise proposals after delivery to the Department, provided the Department receives a request for withdrawal or revision in writing or in person along with proper identification. Provide verification that the written request comes from the bidder or that the individual making the request in person is authorized to do so. Make the request before the specified bid opening date.

B. The Department will allow the apparent low bidder for a project to withdraw any other unopened proposals the low bidder submitted for other projects. If it is later determined that the low bidder's proposal was unacceptable due to irregularities, the bidder cannot claim that a withdrawn bid should then be considered even if the withdrawn bid from another project was also an apparent low bid.

102.11 Public Opening of Proposals.

A. The Department will open and read proposals publicly at the location and time set for the opening.

102.12 Bidder Disqualification.

A. The Department may disqualify a bidder and reject future proposal submissions from the bidder for the following reasons:

1. The bidder defaulted on a previous contract.
2. The bidder received an unsatisfactory past performance evaluation documented by the Department.
3. The bidder failed to submit the required contract release documents, such as certification of payment (CN-91), release of contractor (CN-102), or release of subcontractors (CN-103) for a completed contract.
4. The bidder failed to sign a contract final change order for a completed contract.

B. Provide all releases within 90 calendar days after the date of the final change order or date of contract acceptance, or within 30 calendar days following the resolution of any contract claims, whichever is later.

102.13 Proposal Rejection.

The Department may reject a proposal for any of the following reasons:

1. The bidder submitted more than one proposal for the same work from an individual, firm, or corporation under the same or different name.
2. The bidder colluded with other bidders.
3. The bidder is failing to meet its obligations on other Department contracts.

4. The bidder is failing to pay amounts due on other DelDOT contracts.

102.14 Materials Guaranty.

The contract may require the successful bidder to furnish a submittal that describes the origin, composition, and manufacture of materials the bidder plans to use in the contract, together with samples for Department testing, to ensure conformance with the contract.

102.15 Non-Collusive Bidding Certification.

A. Provide the signed non-collusive bidding certification form provided in the bid proposal.

B. The Department will not consider a proposal for award without the signed non-collusive bidding certification.

C. The Department does not consider bid collusion to include the following:

1. A bidder has published price lists, rates, or tariffs covering items in the proposal.
2. A bidder has informed prospective customers of proposed or pending publication of new or revised price lists for proposal items.
3. A bidder sold the same items to other customers at the same prices in the proposal.

SECTION 103 — AWARD AND EXECUTION OF THE CONTRACT; BID DOCUMENT ESCROW

103.1 Bid Consideration.

A. For projects awarded on the basis of a low bid, the Department will compare proposal prices based on the totals of the extended unit prices. The Department will post the bid tabulations after awarding the project. In the event of a discrepancy between unit prices and the extensions, the unit prices shall take precedence. The Department reserves the right to reject proposals, waive technicalities, reject all bids and advertise the project for rebidding, or reject all bids and not rebid the work. Maximum price provisions, noted elsewhere in the contract, may affect unit bid prices. In such cases, upon discovery of a discrepancy, the Department will adjust the unit bid price to conform to the maximum permissible bid price.

B. For projects not awarded on the basis of a low bid, the bid proposals will indicate what considerations the Department will use to select the successful bidder.

103.2 Contract Award.

The Department will award the contract within 30 calendar days after opening proposals to the bidder that submits the lowest responsive bid. The Department will notify the successful bidder by letter, or by electronic means, of proposal acceptance and contract award. By mutual consent, the Department and the winning bidder may extend the 30-day time limit for contract award.

103.3 Award Cancellation.

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

103.4 Proposal Security Return.

The Department will return proposal securities, except that of the successful bidder, upon contract award. In no event will the Department take any longer than 30 days after the bid opening date to return securities. The Department will return the successful bidder’s proposal security after the Department receives the required performance and payment bonds and the contract is executed. The Department will not return the proposal security of a successful bidder that later decides it wants to be released from the bid due to an alleged error in the proposal preparation.

103.5 Performance and Payment Bonds.

A. Provide a surety bond, or bonds, at the time of contract execution in a sum equal to 100 percent of the contract price. The bond is for the benefit of the Department, as well as for the use and benefit of Delaware’s Division of Revenue in the case of claims under this bond for taxes due to the State. Provide a bond issued by a corporate surety authorized to do business in Delaware.

B. Provide a bond conditioned upon the faithful compliance and performance 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 for such labor, services, or material. Ensure that the bond contains the contractor's guarantee to indemnify and save harmless the State of Delaware, the Department of Transportation, its secretary and all officers, agents, employees, assigns, and servants from all costs, damages, and expenses growing out of, or by reason of, the contractor'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.

C. Ensure that the bond states that every person furnishing materials or performing labor for the contractor 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 due the person from the contractor.

D. Obtain a release from the Division of Revenue on a form provided by the Department showing that all tax obligations are satisfied. Present this form to the Department as a condition for release of the bonds.

103.6 Bid Withdrawal.

If, at any time after the bid opening date before execution of the contract by the Department, the contractor wants to withdraw its bid, submit a written request to the Department's contract administration section stating the reason for the withdrawal request. The Department reserves the right to accept or reject a contractor's request to withdraw a bid and to retain the proposal security in full or in part as liquidated damages. The Department may then proceed to the next lowest bidder or may reject all proposals and re-advertise the work.

103.7 Contract Execution and Approval; Proof of Insurance.

A. Return the signed contract and contract bonds to the Department within 20 calendar days after the notice of award. If the Department has not executed the contract within 15 calendar days following receipt of the signed contract and bonds, the contractor has the right to withdraw the bid without penalty or liability.

B. If the successful bidder is not a Delaware 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.

C. 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 before contract execution. Provide coverage for additional insureds if required by the contract. The Department will not execute the contract until the contractor provides acceptable proof of insurance.

103.8 Failure to Execute a Contract.

The Department will consider failure by the contractor to execute the contract and provide an acceptable bond within 20 calendar days after the notice of award as a revocation of the notice of award and a forfeiture of the proposal security to the Department. The Department may then award the contract to the next lowest bidder or the Department may re-advertise the project.

103.9 Escrow of Bid Documentation.

A. The successful bidder shall submit legible copies of the bid documentation described in this section if required by the bid proposal.

B. Escrow will preserve the contractor’s bid documents for joint use by the contractor and the engineer in resolving disputes and claims and for use in arbitration proceedings, litigation, or negotiations arising from this contract.

C. Before contract execution, submit bid documentation in a sealed container to the Department. Clearly mark the container "Bid Documentation" and label the container with the contractor's name, address, date of submittal, the contract number, and the bid proposal title. The Department and the contractor will jointly deliver the sealed container and an affidavit, in accordance with Section 103.9.C.4., 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. 180 days have elapsed since the date of final acceptance.
2. The Department and the contractor have resolved all disputes arising from, or related to, the contract; and
3. The Department made the final payment for the project, which the contractor accepted.
4. Submit an affidavit on a form provided by the Department, signed under oath by a contractor representative authorized to execute proposals, listing each bid document submitted by author, date, nature, and subject matter. List all the documents the contractor relied upon in preparing the proposal. Ensure that the affidavit states the person signing the document has personally examined the bid documentation and that all bid documentation is included in the sealed container submitted to the Department. Include the signed affidavit with the sealed container.
5. The contractor represents and warrants that the escrowed bid documents provided with the proposal constitute all of the information used in preparation of the contractor's proposal. The contractor shall agree that the Department will not consider any other proposal preparation information in resolving disputes or claims. The contractor also shall agree that the escrowed bid documents are not part of the contract and that nothing in the escrowed bid documents changes or modifies the contract.
6. The escrowed bid documents shall itemize 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. The documents shall provide the detail of:
   a. All labor including direct labor and repair labor;
   b. equipment and equipment ownership;
   c. material quantities including expendable and permanent material; and
   d. subcontract costs.
7. Provide documents that identify allocations of plant and equipment, indirect costs, contingencies, markup, and other items to each direct cost item. Include all assumptions, quantity takeoffs, production rates 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.
8. Submit the escrowed bid documents in the format used to prepare the proposal.
9. The Department may require all documentation used to prepare pricing for extra work that occurs during performance of the contract. The Department will request the documents in writing and the contractor and engineer will place the additional documents in the sealed container held in escrow. The requirements of this specification apply to all documentation supporting pricing for extra work.

10. The escrowed bid documents are intended for joint review by the Department and the contractor to resolve disputes and negotiate contract changes. The Department may review all or any part of the escrowed bid documents in the event of a dispute. The Department is entitled to make and retain copies of escrow documents, provided that the Department executes a confidentiality agreement specifying that the Department will keep all proprietary information contained in the copied documents confidential. The Department will deliver the confidentiality agreement to the contractor. The Department's confidentiality agreement will state that the Department will distribute copied documents only to the Department's agents, attorneys, auditors, and experts aiding the Department in resolving the dispute. The Department will return all original and copied documents to the escrow depository upon resolution of the dispute. The foregoing will not limit the Department's litigation discovery rights with respect to such documents.
11. The escrowed bid documents are the contractor's property and are only subject to the Department's right to review as provided in these specifications. The Department acknowledges 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 contractor's provision of the escrowed bid documents only occurs because providing the documents is a prerequisite to executing a contract.
12. Failure to provide bid documentation will render the proposal non-responsive and the contractor shall forfeit the proposal guaranty in accordance with Section 103.8, Failure to Execute a Contract. The Department will review the escrowed bid documents to determine if the documents are complete. If the Department discovers that documentation is missing, the Department will request in writing that the contractor provide the missing documents. Provide the requested documents within 3 business days of the Department's request. The Department will date stamp the documents received and will label the documents as supplementary material 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.
13. The Department considers the cost for complying with this section incidental to the contract. The Department will bear the storage costs for the documents. The Department will provide escrow instructions to the document depository consistent with this section.

SECTION 104 — SCOPE OF WORK

104.1 Intent of the Contract.

The intent of the contract is to provide for the construction and completion of the work.

104.2 Contract Changes.

A. General.

1. The contract is not modified, altered, or otherwise changed by any oral promise, statement, or representation made either by the Department or the contractor, unless such modification, alteration, or change is reduced to writing in accordance with the contract.
2. The Department reserves the right to change the contract at any time before the contractor's acceptance of the final estimate. After the contractor's acceptance of the final estimate, the Department may only change the contract based on the results of an audit performed in accordance with Section 107.15, Audits.
3. Changes do not invalidate the contract or release the surety and the contractor agrees to perform the work as changed.
4. Proceed with a change only after receiving written direction from the engineer.
5. If the contractor believes it has encountered a change in accordance with Sections 104.2.B, Significant Changes in the Character of Work, 104.2.C, Differing Site Conditions, 104.2.D, Suspensions of Work Ordered by the Engineer, 104.2.E, Extra Work, or 104.2.F, Eliminated Items, provide notice as required by these clauses and as required by Section 104.3, Notification of Contract Changes.
6. Failure to provide notice as specified by these clauses is a waiver of the contractor's entitlement to an increase in the contract price or contract time.
7. If the contractor complies with the notice requirements of these clauses and the engineer determines that there is a change, the Department will compensate the contractor for the change in accordance with Section 109.4, Compensation for Changes, and provide a time extension in accordance with Section 108.7, Extensions of Contract Time.
8. In Sections 104.2.B, Significant Changes in the Character of Work, 104.2.C, Differing Site Conditions, and 104.2.D, Suspensions of Work Ordered by the Engineer, the term "adjustment" means compensation in accordance with Section 109.4, Compensation for Changes, and the granting of a time extension in accordance with Section 108.7, Extensions of Contract Time.

B. Significant Changes in the Character of Work.

1. The Department reserves the right to make, in writing, at any time before the contractor's acceptance of the final estimate, changes in quantities and alterations to the work as are necessary to satisfactorily complete the project. After the contractor's acceptance of the final estimate, the Department may only make changes in the quantities and alternations in the work based on the results of an audit performed in accordance with Section 107.15, Audits. Changes in quantities and alterations will not invalidate the contract or release the surety, and the contractor agrees to perform the work as altered.
2. The Department will make a contract adjustment, excluding anticipated profit, for alterations or changes in quantities that significantly change the character of the work or that cause other

work to become significantly different in character. The Department and the contractor shall agree on the basis for the adjustment before the contractor performs the work. If the Department and the contractor cannot agree on a basis for the adjustment, the Department will make an adjustment either for or against the contractor in accordance with Sections 109.4, Compensation for Changes, and 108.7, Extensions for Contract Time.

3. If the alterations or changes in quantities do not significantly change the character of the work, the Department will pay for the altered work as provided elsewhere in the contract.
4. The Department will apply the term "significant change" only to the following circumstances:
   a. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or
   b. When a major item of work, as defined elsewhere in the contract, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of original pay item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.
   c. When a specialty item of work, as defined elsewhere in the contract, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of original pay item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.

C. Differing Site Conditions.

1. During the progress of the work, if the Department or the contractor encounters subsurface or latent physical conditions at the site differing materially from those indicated in the contract or unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, the party discovering the conditions shall promptly notify the other party in accordance with Section 104.3, Notification of Contract Changes, of the specific differing conditions before the site is disturbed and before the affected work is performed.
2. Upon receipt of the notice provided in accordance with Section 104.3, Notification of Contract Changes, the engineer will investigate the conditions, and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, the Department will make an adjustment, excluding anticipated profits, and will modify the contract in writing accordingly. The engineer will notify the contractor of the determination whether or not an adjustment is warranted.
3. The Department will make no contract adjustment that results in a benefit to the contractor unless the contractor provided the required notice in accordance with Section 104.3, Notification of Contract Changes.

D. Suspensions of Work Ordered by the Engineer.

1. If the Department suspends or delays performance of all or any portion of the work in writing for an unreasonable period of time not originally anticipated, customary, or inherent to the construction industry and the contractor believes that additional compensation or contract time is due as a result of such suspension or delay, the contractor shall submit to the engineer notice in accordance with Section 104.3, Notification of Contract Changes. The contractor shall then

submit a request for adjustment within 7 calendar days after receiving the notice to resume work. The contractor's request shall set forth the reasons and support for the adjustment.

2. Upon receipt of notice, the engineer will evaluate the contractor's request. If the engineer agrees that the cost or time required for contract performance increased as a result of a suspension, and the suspension is excusable and compensable in accordance with Section 108.7, Extensions of Contract Time, the engineer will make an adjustment, excluding profit, and will modify the contract in writing accordingly. The engineer will notify the contractor of the determination whether or not an adjustment is warranted.
3. The Department will make no contract adjustment unless the contractor submitted notice of the suspension in accordance with Section 104.3, Notification of Contract Changes, and submitted a request for adjustment within 7 calendar days of receipt of the notice to resume work.
4. The Department will make no contract adjustment under this clause to the extent that the suspension or delay resulted from any other cause or for which an adjustment is provided or excluded under any other term or condition of the contract.

E. Extra Work.

1. The engineer may direct the contractor to perform extra work. Extra work is work added to the contract for which there is no pay item.
2. The Department will pay for extra work in accordance with Section 109.4, Compensation for Changes, and will provide a time extension for this work in accordance with Section 108.7, Extensions of Contract Time.

F. Eliminated Items.

1. Should the Department find a pay item unnecessary for completion of the work, the engineer may eliminate the item from the contract.
2. If the contractor completed a portion of the work associated with an eliminated pay item, before the Department eliminated the item, the Department will reimburse the contractor for the completed work as follows:
   a. For completed quantities of work, the Department will pay the contractor for each unit of completed work at the contract unit price. If the eliminated pay item is a major item and the reduction in quantity results in a significant change in the character of the work as defined in Section 104.2.B., Significant Changes in the Character of Work, the Department will pay the contractor for each unit of completed work in accordance with Section 104.2.B, Significant Changes in the Character of Work.
   b. For partially completed work, the Department will reimburse the contractor for the partially completed work in accordance with Section 109.4, Compensation for Changes.
   c. Materials the Department paid for will become the Department's property.
3. The contractor is not entitled to reimbursement for an eliminated pay item in excess of 75 percent of the bid amount for the pay item. The only exception to this limit is when the documented material costs alone exceed 75 percent of the bid amount of the eliminated pay item. If this occurs, then the contractor is entitled to the documented material cost but not entitled to reimbursement for an eliminated pay item in excess of 95 percent of the bid amount for the pay item. The material remains the property of the Department and will be delivered to the Department's district maintenance yard.

104.3 Notification of Contract Changes.

A. Immediately notify the engineer of the need for a change. Provide the notification in either written or oral form.

B. Perform work associated with a change only after receiving written direction from the engineer.

C. Within 7 calendar days of the initial notification, provide the engineer with the following information in writing:

1. The date, nature, and circumstances of the occurrence that constitutes the alleged change.
2. The name, title, and activity of each Department representative aware of the alleged change.
3. Copies or descriptions of documents and written accounts of oral communications associated with the alleged change.
4. The basis for the position that the work associated with the alleged change is not already included in the contract.
5. The elements for which the contractor is seeking compensation, including:
   a. Affected pay items.
   b. Additional labor requirements.
   c. Idle labor.
   d. Additional equipment.
   e. Idle equipment.
   f. Additional, eliminated, or wasted materials.
   g. Delays.
   h. Accelerated performance.
   i. Estimated increases or decreases to the contract price or contract time.
   j. Estimated time within which the Department must respond to prevent delays or minimize costs.

D. The Department will consider the contractor's failure to provide the required notice in accordance with this section as a waiver of entitlement to an increase in the contract price or time due to the alleged change, provided, however, that if the estimated increase in the contract price is under $50,000, the Department can waive any of the notice and written information requirements under this section upon the submission of a written request by the contractor within 30 days of the recognition of the need for a change.

E. Within 10 calendar days after the receipt of notice, the engineer will respond in writing to the contractor by:

1. Confirming that there is a change or that a change order is needed and providing direction or indicating when the Department will provide direction.
2. Denying that there is a change.
3. Advising the contractor that the engineer will need more time to evaluate the alleged change.

4. Advising the contractor that it did not submit enough information for the engineer to determine if a change exists. The engineer will describe the information needed and identify the date by which the additional information is needed. The contractor is not entitled to an increase in the contract price or time for costs or delays resulting from the time the contractor spends providing the additional required information after the identified date as provided by the engineer.
5. Advising the contractor that the Department concurs there is a change, but that more information is required to determine the appropriate increase or decrease in the contract price or time. The engineer will describe the information needed to make a determination and will identify the date by which the contractor needs to provide the additional information. If the engineer does not specify a time for submitting the additional information, submit the information within 30 calendar days of the date the engineer informed the contractor that additional information was required.

F. If the contractor disagrees with the engineer's final written response or the engineer's response is untimely, the contractor may pursue a claim in accordance with Section 105.15, Claims Resolution. The contractor's failure to comply with the requirements of Section 104.3, Notification of Contract Changes, is a waiver of the contractor's right to file a claim, provided, however, that if the increase in the contract price is under $50,000, the Department can waive any of the requirements under this section upon the submission of a written request by the contractor within 30 days of the recognition of the need for a change.

G. Submit a waiver request to the Department prior to submitting a claim in accordance with Section 105.15, Claims Resolution. The Department will not consider a waiver request once the notification of claim as been made in accordance with Section 105.15, Claims Resolution.

104.4 Existing Signs.

A. The contractor and the engineer shall inventory all existing signs within the contract limits before work begins. Maintain necessary traffic signs to prevent damage and ensure the integrity of the signs during construction and 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.

104.5 Bus Stops.

Maintain bus stops in accordance with Section 801, Temporary Traffic Control — General.

104.6 Material Testing Certification.

A. For PCC and bituminous concrete material testing, notify the Materials and Research Section of the quantity and time of the scheduled release by 3:00 P.M. of the previous business day.

B. Do not ship PCC or bituminous concrete materials to the job without the materials 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 material shipments.

104.7 Accident Notification.

A. 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 project limits.

104.8 Maintaining Traffic.

A. The contractor may select one of 4 options for the TTC plan for the project. Identify the option the contractor has selected in writing to the Engineer in the preconstruction meeting. The 4 options are as follows:

1. Prepare a new Temporary Traffic Control Plan (TTCP) signed and sealed by a professional engineer registered in the State of Delaware. Ensure that the TTCP is in accordance with all applicable Department standards. Submit to the engineer for approval a minimum of 14-days before starting work.
2. Identify typical applications to be used from the DE MUTCD . Submit to the engineer for approval a minimum of 14-days before starting the work.
3. Identify typical applications to be used from the contract.
4. Commit to the use of the TTC provided in the contract.

B. Keep roads, driveways, entrances, sidewalks, trails, and paths open to vehicular, bicycle, and pedestrian traffic during construction unless otherwise specified in the contract.

C. Ensure that all traffic control measures, and traffic control devices comply with the contract and with the latest edition of the DE MUTCD, including all revisions as of the date the Department advertises the contract. The DE MUTCD is available for download at www.mutcd.deldot.gov.

104.9 Rights In and Use of Materials Found in the Work.

A. The engineer may authorize the contractor's use of materials found in the contract proposed excavation. The Department will pay both for the excavation of such materials at the corresponding contract unit price and for the pay item the contractor uses the excavated materials for.

B. Do not over excavate or remove material that is not within the project grading limits without written authorization from the engineer. If authorization is provided, replace the removed material with acceptable material at no cost to the Department.

104.10 Additional Utility Relocations Required by the Department; Restoration of Surfaces Opened by Permit.

A. 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 is not entitled to damages for unauthorized excavation or any delay caused by the damage.

B. Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit from the Department. The Department will allow parties bearing such permits, and only those parties, to make openings in the highway. Make all necessary repairs resulting from opening the highway when directed by the Department. The Department will pay for repair work as extra

work or as provided in the contract. This work is subject to the same contract conditions as the original contract work.

104.11 Value Engineering Proposals.

A. A contractor may submit a request to modify the contract for the purpose of reducing the total cost or the project duration, or both, providing that it does not reduce design capacity or the quality of the finished product. This request is called a Value Engineering Proposal (VEP). The contractor and the Department will share any cost savings resulting from a VEP on a 50-50 basis. The purpose of a VEP is to encourage contractor innovation.

B. Do not base bid prices on an anticipated approval of a VEP because the Department may not accept the VEP.

C. The Department will notify the contractor if the Department determines that the time for responding to a VEP indicated in the submittal under 104.11.E.5is insufficient for review. 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 contract time extension. The contractor shall have no claim against the Department for contract delays based on the Department's failure to respond within the time indicated in 104.11.E.5 if additional information is needed to complete the review. Until the proposal is accepted by the Department, the contractor remains obligated to the terms and conditions of the existing contract.

D. The Department will only consider VEPs that produce a savings in cost or time, or both, without impairing essential functions and characteristics of the facility, including service life, economy of operation, ease of maintenance, desired appearance, and safety.

E. Submit the following materials and information with each VEP:

1. A statement that the proposal is a VEP.
2. A description of the difference between the existing contract and the proposed change, the advantages and disadvantages between the existing contract and the VEP, 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. An analysis that includes the original estimated costs and quantities the VEP would replace compared to the new costs and quantities resulting from the VEP.
5. A statement specifying when the Department will need to issue a change order adopting the VEP so that the Department obtains the maximum cost or time benefit from the VEP.
6. A statement detailing the effect the VEP will have on contract time.
7. A description of any previous use or testing of the VEP and the conditions and results. If the contractor previously submitted the VEP on another Department project, indicate the date, the contract number, and the action taken by the Department.

F. The Department will consider a VEP only when the VEP meets all the following requirements:

1. The VEP, whether approved or not, applies only to the contract referenced in the VEP and becomes the Department's property. The VEP shall not include restrictions on the Department's use of the VEP. The Department retains the right to use any VEP or part of a VEP on other

projects without obligation to the contractor. This provision is not intended to deny rights provided by law with respect to patented materials or processes.

2. If the Department is already considering certain revisions to the contract or has approved certain changes in the contract for general use that are subsequently incorporated in a VEP, the Department will reject the VEP and may proceed without obligation to the contractor.
3. The contractor shall have no right to claim against the Department for costs or delays due to the Department's rejection of a VEP.
4. The engineer is the sole judge as to whether a VEP qualifies for evaluation. The engineer may reject any VEP for any reason.
5. The Department will reject all or any portion of work performed under an approved VEP if the results are unsatisfactory in accordance with Section 105.15, Claims Resolution. When the Department approves VEP modifications to adjust to field conditions or other conditions, the Department will limit reimbursement to the total amount payable to 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 costs or delays. The Department will not consider any claim based on contract changes as defined in Section 104.2, Contract Changes arising as a result of VEP acceptance.
6. Do not propose work containing experimental features. The contractor shall propose only proven features used under similar or acceptable conditions on other projects or locations.
7. Provide additional information needed to evaluate VEP. The Department will reject a VEP if the submittal of additional information is untimely. Contractor proposed design changes could require additional information including results of field investigations and surveys, design computations, and field change sheets.
8. A VEP proposing to change the type or thickness of the pavement structure will not be considered.

G. If the Department accepts the VEP, the Department will authorize the changes and payment with a change order. The Department will reimburse the contractor as follows:

1. The Department will incorporate changes into the contract by changes in quantities of unit bid items or new agreed price items.
2. The Department will pay the cost of the value engineering work as determined from the changes. In addition, the Department will pay the contractor 50 percent of the VEP savings calculated from the difference between the cost of the revised work and the cost of the original contract unit bid prices. If the VEP provides only a savings in time, the Department will make no additional payment to the contractor.
3. The Department will not reimburse the contractor's costs for development and design of the VEP.
4. The contractor may submit a VEP for an approved subcontractor.

104.12 Final Cleaning of Project Site; Maintenance and Cleanup of Staging Areas.

A. Before primary inspection, clean rubbish, excess materials, temporary structures, and equipment from the project, from any publicly owned borrow source used to complete the work, and from

areas affected by the contractor in connection with the work within the right-of-way. Cut all grass and weeds taller than 6-inches. The cost of the final cleanup is incidental to Item 763000.

B. Install erosion and sediment control measures that comply with stormwater regulations for staging areas. Restore areas used for staging operations to their original conditions. Perform restoration work in accordance with Section 202, Excavation and Embankment, and Section 908, Soil Stabilization Practices. The Department will consider costs associated with restoration of staging areas and establishing an acceptable stand of grass as incidental to Item 763000, Initial Expense, De-Mobilization.

104.13 Contractor's Responsibility for the Work.

A. The contractor is solely and absolutely responsible for the work. 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 achieving substantial completion or the engineer permits opening a section of the work in accordance with Section 105.14, Opening Sections of the Project to Traffic.

B. Rebuild, repair, restore, and make good all losses, injuries, or damage to any portion of the work under the contractor’s control due to the contractor’s fault or inactivity, at no cost to the Department, except as allowed by Section 105.14, Opening Sections of the Project to Traffic. 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 109.4, Compensation for Changes. The Department defines "items not under the control of the contractor" as earthquakes, tidal waves, tornadoes, or hurricanes; catastrophic conditions such as hazardous waste materials spills or explosions; or, acts of public enemy or of governmental authorities.

C. In case of a work suspension:

1. Maintain responsibility for the project and take precautions necessary to prevent damage to the project.
2. Provide for normal drainage and normal traffic operations.
3. Erect temporary bridges, signs, or other facilities as needed.
4. Continuously maintain living material in newly established plantings, seedings, and sod provided under the contract.

104.14 Required Notifications for Disturbing Property and Using Bridges.

A. Provide 2-weeks notice to property owners before removing any fixture, shrub, or other object from a right-of-way or easement area that may belong to the property owners. If the owners do not attempt to salvage this property within the 2-week period, remove it without further obligation.

B. Before starting any work that will change the loadings on an existing or proposed bridge, inform the engineer of the proposed loadings, including axle spacing, axial loads, stockpiling, equipment locations, and the quantity of and type of construction equipment and vehicles proposed for use. The loading that the contractor's equipment will apply to the bridge is subject to the engineer’s approval. 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

specifications. If at any time the contractor's upcoming operations would result in a change to the loading or the location of the loading on a bridge, submit the proposed loadings to the engineer for approval before changing the loading. Perform no work that will change the loadings on any bridge until the contractor obtains the engineer's approval. The engineer will review the changes in accordance with Section 105.4, Plans, Shop Drawings, and Working Drawings.

104.15 E-Construction.

A. The Department requires the use of various E-Construction applications for various documentation processes depending upon the Project being constructed. Unless otherwise noted in the RFP, the Department's E-Construction application is Oracle Primavera Unifier (Unifier). The Contractor is required to use Unifier for reviewing, approving, acknowledging and/or electronically signing processes related to Change Orders, Estimates, Requests for Information, Submittals, Time Charges, etc. for the Project through Unifier. No additional payments will be made to the contractor to use or interface with the Department's E-Construction application(s) that are identified in either the General Specifications and/or Project RFP. No additional payments will be made to the contractor for additional licenses for the E-Construction application beyond the license(s) provided by DelDOT.

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

105.1 Authority of the engineer.

A. The engineer is the contract administrator and not a supervisor of the work. The contractor shall perform all work to the engineer's satisfaction but shall maintain complete responsibility for the work. The engineer will decide all questions that may arise regarding:

1. Material quality and acceptability;
2. work performed;
3. the manner of performance;
4. the rate of progress of the work;
5. the interpretation of the plans and specifications;
6. the acceptable fulfillment of the contract;
7. disputes and mutual rights between contractors; and
8. compensation.

B. At the preconstruction meeting, the engineer will explain the chain of authority.

C. The engineer has the authority to suspend the work, wholly or in part, due to the contractor's failure to:

1. Correct conditions that are unsafe for the general public;
2. carry out contract provisions; or,
3. carry out the engineer's directions.

D. The engineer has the authority to suspend work for periods of time the engineer decides are necessary due to conditions unsuitable for prosecuting the work or for any other condition or reason the engineer decides is in the public interest.

E. The engineer or the inspector working under the engineer's authority may issue a written stop work order to the contractor. The order will provide the reason for the work stoppage. The engineer or the inspector working under the engineer's authority will give the stop work order directly to the contractor's representative in charge on the project site or will send an electronic copy to a responsible party in the contractor's organization. Once the stop work order is delivered, the inspector will immediately leave the job site. The Department will not pay for, and may not accept, work performed by the contractor during the inspector's absence.

F. The engineer's authority to impose any available contract sanction will not relieve the contractor of responsibility for the project, the performance of the work, and the safety of workers and the general public. The contractor holds the Department harmless pursuant to Section 107.10, Responsibility for Damage Claims, for any violation, breach, or omission of this contract provision.

105.2 Authority and Duties of Inspectors.

A. Inspectors acting under the engineer's authority are contract administrators and not supervisors of the work. Inspectors employed by, or designated by, the Department are authorized to inspect the contractor's work and materials. Inspection includes all or any part of the work and the preparation, fabrication, or manufacture of materials. The inspector is not authorized to revoke, alter, or waive any requirements of the contract. The inspector may call the attention of the contractor to work or materials that do not to conform to the contract. The inspector has the authority to reject materials or suspend the work until any questions at issue are referred to the engineer for decisions. Inspection does not relieve the contractor of its obligation to perform the work in accordance with the contract.

B. The inspector has no authority to interfere with the contractor's management of its work. Do not interpret the advice an inspector may offer as binding on the engineer or interpreted as releasing the contractor from fulfilling the terms of the contract.

105.3 Inspection of the Work.

A. Allow access to inspect the work at any time. Provide any information and assistance required to conduct inspections. Inspection may include any facility that produces material provided under these specifications. The engineer's failure, for any reason, to discover defective work or materials during facility inspections does not affect the engineer's authority to reject materials or work at any time before final acceptance. The engineer is not responsible for losses the contractor may incur due to removal or repair of defects the engineer discovers.

B. Remove finished work, for inspection of work obscured by the finished work, or uncover finished work for inspection when directed at any time before final acceptance. After the engineer examines the exposed work, restore the inspected area to the contract requirements. If the exposed work is acceptable to the engineer, the Department will pay the cost of uncovering and restoring the area as extra work. If the exposed work is unacceptable to the engineer, the contractor shall bear the cost to uncover, remove work, inspect the exposed work, and restore the area to the contract requirements.

C. The Department may order any work the contractor performs, or materials the contractor places, without inspection by the Department representative, removed and replaced at the contractor's expense.

D. 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, the respective representatives have the right to inspect the work. These inspections 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 the Department or the contractor.

105.4 Plans, Shop Drawings, and Working Drawings.

A. The Department will provide plans with the bid proposal of sufficient detail to convey a comprehensive understanding of the work specified. Keep one copy of the plans and the bid proposal at the project site at all times. Provide shop drawings and working drawings as required by the contract. Unless waived in writing by the engineer, provide shop drawings and working drawings signed and sealed by a professional engineer registered in the State of Delaware.

Identify shop drawing and working drawing submittals by the contract number. Identify items or component materials by the specific pay item number and specification reference in the contract.

B. Do not incorporate any changes from the requirements of the contract in the shop drawings unless the changes are specifically denoted, together with justification, and approved in writing by the engineer.

C. The contractor is responsible for preparing shop drawings and working drawings. The Department will accept drawings submitted directly by the supplier or the contractor's representative as long as the contractor was notified and has authorized the submission.

D. Show details, dimensions, sizes of units, and other information necessary for fabrication and erection of metal work on metal structure shop drawings.

E. Provide details on working drawings required for performance of the work. Include plans for falsework, bracing, sheeting, shoring, cofferdams, formwork, masonry layout diagrams, bending diagrams for reinforcing steel, and any others specified in the contract.

F. Submit copies of manufacturer’s catalog cuts, drawings, wiring diagrams, and other relevant documents with working drawings for electrical and mechanical equipment. After the Department has reviewed all items of a particular system, prepare an instruction book for the particular system. Fasten and bind the items listed below in a leather or heavy plastic cover book with a title clearly shown. Provide five copies of the book to the engineer before primary inspection. Make the books available when connecting and energizing electrical and mechanical systems. Ensure that the final bound copies reflect changes or adjustments made during the work. Include the following in the instruction book:

1. An equipment list.
2. A complete description of the equipment.
3. The sequence of operation including inter-locking and protective features.
4. The use of by-pass switches.
5. A detailed description of all wiring circuits.
6. A recommended spare parts list.
7. Renewal parts bulletins.
8. Instruction bulletins for the provided equipment.
9. Diagrams and drawings of reduced size suitable for binding.
10. An index listing all items.

G. Submit electronic copies of working drawings to the engineer, unless otherwise stated at the preconstruction meeting. Should questions arise as to the proper procedure for submitting working drawings, obtain clarification from the engineer. The engineer will return drawings stamped as one of the following:

1. "Returned for Resubmission." Drawings returned with this stamp require revisions or corrections and resubmission for review.

2. "Reviewed for General Conformity with Plans and Specifications." Drawings returned with this stamp may contain comments from the Department. If the Department and the contractor agree on the comments, incorporate the comments in the drawings and the Department will not require resubmission. If the Department and the contractor do not agree on the comments, provide the reasons for disagreement in writing and submit the response to the Department within 10 working days after receipt of the Department's comments.

H. The Department does not review every detail of every working drawing or other submittal the contractor submits. The Department accepts no responsibility for the completeness or accuracy of approved submittals or the failure of approved submittals to conform to the contract requirements.

I. The Department will return reviewed working drawings, submittals, or resubmittals to the contractor within 21-days from the date the Department received the documents. If the contract requires review by a railroad, the U.S. Coast Guard, municipality, or other entity specified in the contract, the Department will return the reviewed documents 60-days from the date the Department received the documents. The contractor is not entitled to additional compensation, if the Department does not return working drawings, submittals, or resubmittals by the specified time. The Department will consider a contract time extension, in accordance with Section 108.7, Extensions of Contract Time, in the event that the Department does not return the documents within the required time period.

105.5 Conformity with the Plans and Specifications.

A. Perform all work in accordance with the lines, grades, cross-section, dimensions, and material requirements, including tolerances, shown in the contract. If the contract does not provide a tolerance, then perform the work in reasonably close conformance to the lines, grades, cross-section, dimensions, and material requirements shown in the contract.

B. If the engineer finds that the materials or the finished product are not in accordance with the contract, but that the contractor produced otherwise acceptable work, the engineer will make a determination about accepting all the work and allowing the work to remain in place. In this event, the engineer will document the basis of acceptance that may provide for an appropriate adjustment in the contract price for such work or materials.

C. In the event the engineer finds the material, or the finished product, or the work performed is not in accordance with the contract, and the result is an inferior or unsatisfactory product, remove and replace or otherwise correct the work or materials at no cost to the Department. If the contract contains provisions for the acceptance of materials or work not in full compliance with the minimum requirements stated, the Department will adjust the contractor's compensation based on those provisions.

105.6 Coordination of the Contract Documents.

A. Each individual contract document is an essential part of the contract and a requirement occurring in one is binding as though occurring in all. The contract documents are complementary and describe and provide for a complete contract. In the case of a conflict between the contract documents, the order of precedence is as follows:

1. General Description

2. General Notices
3. Plans
4. Special Provisions
5. Standard Construction Details
6. Standard Specifications
7. Electronic Design Data Files

B. Do not take advantage of any apparent error or omission in the contract. Upon discovery of an error or omission, promptly notify the engineer. The engineer will make corrections and interpretations as necessary to fulfill the intent of the contract.

C. Plan dimensions take precedence over scaled measurements.

D. Prior to performing the associated work, issue a written Request For Information (RFI) if any questions arise during the project, if interference or conflict is caused by the design, or if errors and omissions exist in the contract. The engineer will respond to each RFI in writing clearly indicating any applicable design revisions.

E. Upon identification of a deviation from the specified sampling or testing procedures or contract by the contractor, inspector, or any representative thereof, submit for approval a written non-conformance report (NCR), including its associated corrective actions and plans on how to prevent future non-conformance events, covering such deviation. Include in the NCR, a description of construction activity and the location by specification.

F. The Department will require 3 working days from receipt of the written notice to review and respond to an RFI. The Department will respond by answering the RFI question or by informing the contractor that the Department will need additional time to review the RFI question.

105.7 Contractor's Supervision.

A. Provide organizational resources, including supervision, management, and engineering services to assure contract performance.

B. Provide a competent superintendent or supervisor who is:

1. An employee of the firm;
2. has full authority to direct performance of the work;
3. has authority over all construction operations;
4. is capable of reading and understanding the contract; and
5. is experienced in the type of work the superintendent or supervisor will oversee.

C. Ensure that a superintendent or supervisor is present on site at all times during contract work. The superintendent or supervisor is the point of contact for the engineer, is authorized to act for the contractor, and is authorized to execute the engineer's directions.

105.8 Cooperation Between Contractors.

A. The Department reserves the right to contract for and perform work on or near the limits of construction covered by the contract.

B. Separate contractors performing work on the same project shall coordinate the work and cooperate with each other. The engineer will make decisions in the event of disputes between the contractors. When the Department lets separate contracts within the limits of any one project, each contractor shall perform its work without interfering with, or hindering the progress of, the work by other contractors.

C. Each contractor on the project site shall assume liability, financial or otherwise, in connection with its respective contract covering its respective work area. Protect and save harmless the Department from any and all damages or claims that may arise because of inconvenience, delays, or loss experienced due to the presence and operations of other contractors working within the limits of construction of the same project.

D. 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.

105.9 Utilities within the Project Limits; Miss Utility One-Calls.

A. The Department alerts the bidders that the successful contractor may encounter utilities within the limits of the work under this contract. The locations of utilities shown in the contract are approximate and are for information only.

B. Prior to advertisement, the Department will notify all utility companies, pipeline owners, railroads, or other parties known to have facilities within the LOC. The Department will make every effort to have all necessary utility relocations within or adjacent to the LOC made as soon as practicable. Do not proceed with the work before consulting with the engineer, the utility companies, and municipal or county authorities in an effort to secure the most accurate and most recent information regarding utility locations. As required by Chapter 8, Title 26 of the Delaware Code, do not begin construction in close proximity to utilities without notifying the Utilities Service Protection Center of Delmarva, Inc., commonly referred to as “Miss Utility,” at least 2 working days, but not more than 10 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.

C. Owners of utility facilities within the LOC, that require relocating or altering to perform the contract work, are responsible for moving utilities at the utility owner’s cost, except as otherwise provided in the contract. If traffic control is in place for the Department’s project, allow the utility contractors performing the work during the contract period to work within the maintenance of traffic (MOT) devices. The respective utility contractors are responsible for the safety of their personnel and for their own construction area while working within the LOC. If a traffic control system is not in place for the Department’s project, utility contractors performing work within the traffic zone shall provide their own MOT devices at their own expense, including flaggers if required. The engineer reserves the right to direct the contractor to provide MOT devices for utility contractors working within the traffic zone. If the engineer requires the contractor to provide MOT devices for other contractors, the engineer will pay for the work under the contract unit prices. If the contract does not have unit prices for MOT devices required by the engineer, the engineer will negotiate prices 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 relocating or rearranging existing utilities solely for contractor convenience.

D. The Department will require that utility companies remove excess excavation material from utility trenching performed by the utility companies, unless the engineer directs the contractor to use the material as part of the project.

E. The Department will not allow compensation for delays, inconvenience, or damage due to interference from, or the operation of moving, existing utilities. The Department may consider a contract time extension under these circumstances.

F. The contractor may experience relocation of existing utilities that conflict with proposed construction, construction of new utilities, or reconstruction of existing utilities occurring simultaneously with the contractor's work under the contract.

G. Immediately notify utility owners and arrange for repair of damage to existing utilities caused by the contractor's operations. The contractor shall bear all costs related to the repairs.

H. Comply with 16 Del. C. Chapter 74B known and cited as the "Overhead High-Voltage Line Safety Act." Maintain a distance of at least 10 feet or more, as determined by the operating utility, from any high voltage overhead line.

105.10 Construction Stakes, Lines, and Grades Provided by the Department.

A. The engineer will provide and set control points and construction stakes unless otherwise specified in the contract.

B. The engineer will set construction stakes establishing right-of-way, limits of construction, and easement lines, cross slopes, profile grades, centerlines or off-set lines, and benchmarks. The Department may provide the contractor with information relating to 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 the Department stakes and marks as field control for establishing other necessary controls and performing the work. Before beginning work, ensure understanding of all Department layout information.

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

D. Protect Department stakes and marks. The Department will deduct the cost to replace disturbed or destroyed stakes and marks from monies due or to become due to the contractor.

E. The Department is responsible for the accuracy of lines, slopes, grades, and other engineering work set forth under this section. Provide the Department with 10 calendar days of notice before beginning work that requires staking. Once work has begun, provide the Department notice at least 2 business days before needing stakes. The Department will not accept responsibility for staking delays if the contractor fails to provide the required notices.

105.11 Removal of Defective and Unauthorized Work.

A. Remove and dispose of unacceptable work immediately upon rejection by the engineer at no cost to the Department. The engineer will consider any work that does not meet the requirements of the contract as defective and unacceptable.

   1. The Department may elect to permit the correction of the unacceptable work in lieu of removal and replacement. The corrective action will not waive any penalty or warranty owed to the Department from the original unacceptable work. The Department will not make any additional payment for corrective actions undertaken by the contractor at the direction of the engineer due to defective or unacceptable work.

   2. The engineer will consider work performed without adequate layout, work performed beyond the lines and grades shown on the plans, or any extra work performed without written direction from the engineer as unauthorized work. The Department will not measure or pay for unauthorized extra work. The engineer may direct the contractor to remove and replace unauthorized work at the contractor's expense.

B. Failure to remove the work may result in contract termination depending on the nature and extent of the rejected work. The engineer has the authority to have unacceptable work corrected, removed, or replaced and will deduct the costs incurred from money due the contractor.

105.12 Load Restrictions.

A. Comply with all legal and contractual load restrictions for hauling 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 results from the movement of materials or equipment.

B. Use vehicles for transporting construction materials to Department projects that do not exceed the gross vehicle weight (GVW) or licensed weight, if less, as specified in the Delaware code. The Department will not issue materials inspection weigh tickets for GVWs in excess of the allowable maximum. Ensure that the allowable GVW for each delivery truck is on each material ticket submitted to the engineer.

C. Payment for material weight delivered to the project will not exceed the allowable GVW minus the truck tare weight. The contractor may establish an average tare weight on a basis approved by the engineer so that empty weighing is not necessary before every load. The Department will not pay for excess material weight. Notify subcontractors, vendors, and suppliers of this requirement.

D. The maximum GVW for different vehicle axle configurations is as follows:

Table 105.12-1. 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.

*Indicates when an extra weight fee has been paid and is so noted on the registration card.

E. The contractor is responsible for damage caused by hauling equipment, whether the damage occurs inside or outside the project limits.

105.13 Maintenance During Construction.

A. Maintain the work during construction every day to keep the roadway and structures in an acceptable condition until project acceptance. The Department will perform snow removal unless the contract specifically assigns this responsibility to the contractor. The Department will mow the grass outside the LOC.

B. The engineer will notify the contractor if there is a failure to comply with these provisions. If the contractor fails to remedy unsatisfactory maintenance within 24 hours after receiving the engineer's notice, the engineer may proceed to maintain the project. The Department will deduct the maintenance cost from monies due or to become due to the contractor.

C. If the contract involves placement of material on a previously constructed subgrade, base course, pavement or structure, maintain the previously constructed work during construction operations.

D. Include the cost of maintenance work during construction and before completion of the primary inspection punchlist in the proposal. The engineer will pay the cost of maintenance work occurring after completion of the primary inspection punch list.

E. In the event that the engineer suspends the work for failure to comply with the contract, maintain traffic, protect and maintain the roadway and structures, and provide ingress and egress for residents during the suspension. Perform these functions until the engineer lifts the suspension or until the Department declares the contract in default.

F. Mow all grass and weeds within the LOC, as directed by the engineer, to a height in accordance with Section 104.12, Final Cleaning of Project Site; Maintenance and Cleanup of Staging Areas. If the engineer directs mowing more than 4 times in a calendar year, the Department will pay for mowing costs beyond the fourth mowing operation.

105.14 Opening Sections of the Project to Traffic.

A. The engineer may order opening of certain sections of the work to traffic or other use before the contractor completes the work or before the engineer accepts the work. The Department will not consider opening sections of the work as constituting acceptance of the work or a waiver of any contract provisions. The engineer will pay the cost of repairing damage to the work caused by opening work to vehicular traffic unless opening the roadway is 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 and general cleanup are the contractor's responsibility until completion of the primary inspection punch list to the Department's satisfaction. Maintenance costs for work involving landscaping and vegetative growth are the contractor's responsibility until final acceptance.

B. If the contractor desires to open a section of roadway to traffic, obtain the engineer's approval and have traffic control devices in place and functioning before opening.

C. Opening a section of the work to traffic or other use does not solely determine substantial completion.

105.15 Claims Resolution.

A. General.

1. A claim is a written demand by the contractor seeking:

   a. The payment of money.

   b. A contract time extension.

   c. Other relief, including the modification of the contract terms.

2. The contractor and the Department will resolve all contract changes arising under or related to the contract that the contractor and the Department do not resolve through the process set forth in Section 104.3, Notification of Contract Changes, using the process described in this section. Notify the engineer of the intent to file a claim within 10 days from the engineer's final response in accordance with Section 104.3, Notification of Contract Changes.

3. The engineer will respond to the contractor within 10 days of receipt of the contractor's notice of intent to file a claim. In this response, the engineer will acknowledge receipt of the notice. In addition, if the engineer's position regarding the issue raised in the notice has changed since the engineer's response to the same issue at the conclusion of the process set forth in Section 104.3, Notification of Contract Changes, the engineer will describe how its position has changed. Follow all the procedures established in this section for unresolved issues.

4. Except as provided for in Section 7 and below, for all claims arising under, or related to, the contract, the contractor must complete every step in the procedures established in this section, including, but not limited to the timeframes and compliance with Section 104.3, Notification of Contract Changes. If the contractor fails to complete every step in the procedures established in this section and Section 104.3, Notification of Contract Changes, the contractor waives entitlement to compensation, an extension of contract time, or other relief for its claim.

5. Continue the work, including the work associated with the claim, while the parties complete the procedures established in this section.

6. Upon written request of the contractor, compliance with the requirements of Section 104.3, Notification of Contract Changes, may be waived by the Department if the increase in the contract price is under $50,000. Such written request must be made prior to filing a claim pursuant to Section 105.15, Claims Resolution. Any waiver requests made after the deadline to file a claim under Section 105.15, Claims Resolution, will not be considered by the Department. For the avoidance of doubt, only the requirements of Section 104.3, Notification of Contract Changes, may be waived and a contractor cannot cure any other deficiency in the requirements under this section by requesting a waiver.
7. If the contractor submits a request in writing and the Department agrees in writing, the Department may extend the contractor's timeframes specified in this section. The Department may extend any timeframe that applies to the Department for any reason upon written notice to the contractor.
8. The contractor has the burden of proof regarding establishing its entitlement to the payment of money, a contract time extension, or other relief being sought.
9. The Department will not consider a claim submitted by a subcontractor unless the following conditions are established:
   a. The contractor, subcontractor, and the Department have attempted to resolve the issue through the notification and resolution process required by Section 104.3, Notification of Contract Changes.
   b. The contractor provided the Department with written certification by the contractor that the contractor reviewed the subcontractor's claim and verified that the claim was fully documented and supported in accordance with the claim certification requirements of Section 105.15.C.7.
   c. The contractor agrees in writing to pay to the subcontractor the full amount of the subcontractor's certified claim.
   d. The subcontract and any releases or waivers the subcontractor executed do not bar payment to the subcontractor.
   e. The subcontractor's claim submission includes a copy of the executed subcontract, all changes or modifications to that subcontract, and all fully executed releases or waivers with the contractor.
10. If the contractor refuses to certify a claim submitted by a subcontractor, then the contractor waives entitlement to compensation, an extension of contract time, or other relief from the Department for the subcontractor's claim.
11. The Department will not review and will reject claims pursued by subcontractors or suppliers directly with the Department that the contractor refuses to certify.
12. If it is determined that the contractor is entitled to compensation or a contract time extension, the Department will determine the compensation or the time due the contractor in accordance with Sections 109.4, Compensation for Changes, and 108.8, Failure to Complete on Time, respectively.

B. Contractor Claim Notification.

1. Notify the engineer orally and in writing of the intent to file a claim before beginning the affected work or within 15 calendar days of completing the process set forth in Section 104.3, Notification of Contract Changes, whichever is later.
2. If the Department has previously agreed to waive all or part of the process set forth in Section 104.3, Notification of Contract Changes, a contractor must notify the engineer orally and in writing of the intent to file a claim within 15 calendar days of completing the affected work, or within 15 calendar days of the Section 104.3, Notification and Contract Changes, waiver being granted, whichever is sooner.
3. Unless waived in writing by the Department, before providing a notice of intent to file a claim, the contractor and the Department must complete the notification and resolution process required by Section 104.3, Notification of Contract Changes. If the contractor does not comply with the process in accordance with Section 104.3, Notification and Contract Changes, and does not request a waiver of the Section 104.3, Notification of Contract Changes process prior to completing the affected work, the contractor waives its entitlement to compensation, an extension of the contract time, or other relief for the issue.
4. If the contractor has not provided the notification required by Section 104.3, Notification and Contract Changes, and has not completed the resolution process set forth in Section 104.3, Notification of Contract Changes, the Department has the right to evaluate the contractor's intent to file a claim in accordance with the requirements and processes set forth in Sections 104.2, Contract Changes, and 104.3, Notification of Contract Changes, including the notification requirements of those provisions.
5. If the contractor refuses to first address the resolution of the issue associated with the notice of intent in accordance with Section 104.3, Notification of Contract Changes, the contractor waives its entitlement to compensation, an extension of the contract time, or other relief for the issue.
6. Provide the following information with the written intent to file a claim:
   a. The date of the occurrence and the nature and circumstances of the occurrence that constitutes a change to the contract.
   b. The name and title of the Department representatives knowledgeable of the facts, conditions, and circumstances that form the basis of the contractor's claim.
   c. The specific elements of the contract or the contractor's performance for which the contractor seeks compensation, an extension of the contract time, or other relief.
7. If the contractor fails to submit written notification to the engineer within the time limits set forth in this section, the Contractor waives entitlement to compensation, a contract time extension, or other relief for the claim.
8. Substantiate and document costs and delays for which the contractor is seeking compensation or a contract time extension.
9. Provide the engineer with the proper facilities for keeping account of the costs and delays for which the contractor is seeking compensation or a contract time extension.
10. If the contractor does not document costs and delays and the contractor does not provide the engineer with the proper facilities for keeping account of the costs or delays the contractor

incurs, the contractor waives entitlement to compensation, a contract time extension, or other relief sought by the claim.

11. Notice by the contractor, and the fact that the engineer has kept account of the costs or delays, does not establish the contractor's entitlement to the compensation, extension of contract time, or other relief sought by the claim.
12. Nothing contained in this section establishes the contractor's entitlement to compensation or a contract time extension contrary to the terms of Sections 104.2, Contract Changes, 104.3, Notification of Contract Changes, 108.7, Extensions of Contract Time, 109.4, Compensation for Changes, or other contract provisions.

C. Claim Submittal.

1. A contractor must submit a written claim to the engineer within 30 calendar days after completing the work described in the notice of intent to file a claim.
2. Prepare a written claim submittal containing at a minimum the following information.
   a. For claims less than or equal to $250,000:
      i. A narrative with sufficient information to allow a third party to understand the issue in dispute and its effect on the work.
      ii. A description of the nature and basis for the claim.
      iii. The facts the contractor relies on to support the claim.
      iv. The reasons why the contractor believes it is entitled to relief.
      v. The contract language the contractor relies on to support its claim for entitlement to compensation, a contract time extension, or other relief.
      vi. The compensation, contract time extension, or nature and extent of other relief the contractor believes it is entitled to.
      vii. Progress schedules and a schedule analysis prepared in accordance with Section 108.7, Extensions of Contract Time, when requesting a time extension.
      viii. When requesting compensation for acceleration, documentation and an analysis establishing that the contractor accelerated the work to mitigate a delay for which the contractor would otherwise be entitled to a time extension and establishing that this acceleration resulted in a time savings.
      ix. Documentation verifying the compensation the contractor seeks. Provide documentation in accordance with Section 109.4, Compensation for Changes.
      x. Daily logs or diaries, daily time sheets, timecards, foreman's daily reports, and similar records prepared by the contractor.
      xi. Meeting minutes, correspondence, photographs, and other documentation that support the claim.
      xii. Other information that supports the claim.

b. For claims greater than $250,000, in addition to the information listed in Section 105.15.C.2.a. above:

i. Union agreements the contractor has not already provided the Department.

ii. Insurance policies, welfare and benefit records, and other records that document the actual benefits paid to, or on behalf of, the contractor's labor that the contractor has not already provided to the Department.

iii. Payroll registers.

iv. Job payroll ledger and individual employee earnings records.

v. Payroll tax returns.

vi. Material invoices, purchase orders, and material and supply contracts or purchase orders.

vii. Material cost distribution worksheets.

viii. Equipment records, including a list of contractor-owned or rented equipment, rates, daily equipment reports or logs, fueling logs or records, and equipment lease or purchase agreements.

ix. Proof of purchase price and depreciation records on company equipment for which the contractor is seeking compensation.

x. Rental agreements.

xi. Subcontractor invoices.

xii. Subcontracts.

xiii. Subcontractor payment certificates.

xiv. Canceled checks or other proof of payment.

xv. Initial, final, and monthly job cost reports.

xvi. Earnings reports and other related or similar reports.

xvii. General ledger, general journal, and all subsidiary ledgers and journals together with all supporting documentation pertinent to entries made in these ledgers and journals.

xviii. Cash disbursements journal.

xix. Financial statements for all years from the bid opening date through the claim certification date.

xx. Income tax returns for the year of the proposal due date through the claim certification date.

xxi. All documents that show the contractor's actual profit and overhead for 5 years preceding the year of the proposal due date through the claim certification date.

xxii. All documents and calculations related to the contractor's proposal preparation, including the final calculations the contractor based the bid on.

xxiii. Electronic spreadsheets and workbooks in the native format the contractor used to prepare the claim submittal and calculate the claimed costs.

xxiv. Other information requested by the Department.

c. The contractor may request in writing a waiver of documents from the list set forth in Section 105.15.C.2. The engineer will review the contractor's written request and respond in writing in 10 calendar days.

3. Submit 3 complete copies of the written claim and all supporting documentation to the engineer.

4. Provide the claim and all supporting documentation electronically in native electronic formats, if requested by the Department. Provide schedules as P6 .XER files, spreadsheets as Excel.xlxs or .xls files, and narratives as Microsoft Word files.

5. The Department may waive the contractor's obligation to submit some portion of the required documentation upon the contractor's submission of a written request to the engineer.

6. In addition to the documentation requirements of a written claim, the Department has a right to conduct an audit of the contractor's records in accordance with Section 107, Legal Relations and Responsibility to the Public. The Department's decision to conduct an audit does not reduce the documentation requirements of a written claim.

7. Provide the following claim certification with the claim documents:

> 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 compensation, extension of contract time, or other relief for which (the contractor) believes that the Department is responsible.
>
> (THE CONTRACTOR)
>
> By: _____
> (Name) (Title)
> Date of Execution: _____

8. Unless waived by the Department under this section, if the contractor fails to submit the information, documentation, schedules, analyses, and certification listed above, the contractor waives its entitlement to compensation, an extension of contract time, or other relief for the claim.

9. The contractor's entitlement to compensation and an extension of time for a claim is limited to the compensation allowed by Section 109.4, Compensation for Changes, and the time extension allowed by Section 108.7, Extensions of Contract Time.

D. The Engineer's Review.

1. Upon the receipt of the contractor's properly certified claim, the engineer will review the claim submittal to confirm that the submittal is complete and certified as required by Section 105.15.C, Claim Submittal.

2. If the engineer determines that the claim submittal is not complete and properly certified, within 10 days of engineer's receipt of the claim submittal, the engineer will notify that

contractor in writing of the deficiencies in the submittal. Until the contractor remedies the deficiencies identified by the engineer, the Department will take no further action on the contractor's claim. If the contactor does not correct the deficiencies within 30 days of the engineer's written notice of deficiencies, the claim is considered to be withdrawn and the contractor has waived entitlement to compensation, an extension to the contract time, or other relief that was sought by the claim.

3. Within 30 days of the receipt of the contractor's complete and properly certified claim submission, the engineer has 2 options:
   a. If the engineer's position regarding the claim has changed from the position held when the engineer received the contractor's notice of intent to file a claim, the engineer will notify the contractor in writing and schedule a meeting with the contractor to negotiate and resolve the claim.
   b. If the engineer's position regarding the claim has not changed, the engineer will notify the contractor in writing that the engineer's position regarding the claim is unchanged.
4. Within 10 days of the engineer's written response, the contractor has 2 options:
   a. The contractor may agree to meet with the engineer to negotiate and resolve the claim if the engineer has offered this option.
   b. The contractor may refuse to meet with the engineer or accept the engineer's written response to the claim and appeal the claim to the District Engineer.
5. If the contractor decides to appeal, submit the appeal within 30 days of receipt of the engineer's written response.

E. District Review.

1. The District Engineer will review the contractor's formal written appeal and the contractor's claim completed and properly certified claim submission if it is appealed timely.
2. Within 30 calendar days after receiving the formal written appeal and claim, the District Engineer will meet with the contractor to present the results of the District's evaluation. The District and the contractor will attempt to reach agreement during the meeting and resolve all or part of the claim.
3. If the District and the contractor are not able to resolve all or part of the claim, the District will issue a written decision regarding that portion of the claim that was not resolved within 15 calendar days of the meeting. The District's written decision will include the amount of money or time, if any, that the District concludes the contractor is due, and the reasons why the contractor is not entitled to the full amount of time or money claimed.
4. At the District's sole discretion, the District will notify the contractor if the District needs additional time to review the claim and to prepare the written decision.
5. If mutually agreed, including agreement to the extension of applicable time limits, the parties may engage in non-binding alternate dispute resolution such as mediation to facilitate resolution of the appeal.
6. The District and the contractor may conduct non-binding dispute resolution in addition to, or instead of, the District meeting with the contractor.

7. If the meeting with the contractor and the non-binding dispute resolution are unsuccessful, the District Engineer will issue a written decision regarding the unresolved portion of the claim within 15 calendar days after the meeting, or the non-binding dispute resolution effort, whichever is completed later.

F. Contractor's Appeal to the Claims Committee.

1. If the amount of the unresolved portion of the claim is greater than $100,000 after the completion of the District's review, the contractor may appeal the District's decision to the Department's Claims Committee.
2. If the amount of the unresolved portion of the claim is less than or equal to $100,000 after the completion of the District's review, the contractor may appeal the District's decision to the Secretary for the Secretary's Decision as set forth in Section 105.15.G, Secretary's Decision.
3. Whether to the Claims Committee or the Secretary, submit the written notice of appeal within 10 calendar days of the date of the District's decision.
4. Failure to provide timely notice of an appeal constitutes a waiver of the contractor's right to appeal the District's decision regarding the claim. The contractor's entitlement to compensation, a contract time extension, or other relief is limited to the amounts set forth in the District Engineer's written decision regarding the claim.
5. Pre-Meeting Conference.
   a. The Chair of the Claims Committee will designate either the Claims Committee or the claims committee's legal counsel to act as a Referee to hold a pre-meeting conference at least 5 business days before the claims review meeting to expedite the meeting of the case by:
      i. Simplifying factual and legal issues by stipulation;
      ii. Advising both the Department and the contractor of the time limits set for the claims review meeting by the claims committee. Each side will be allocated an equal portion of time to present its case and each side may not exceed the time allotted without the express permission of the Claims Committee;
      iii. Resolving any preliminary or procedural matters; and
      iv. Pre-marking for identification and admission into evidence all exhibits.
      v. Failure of a party to participate in a pre-meeting conference may be a ground for the Chair to continue the hearing.
6. Pre-Meeting Submissions.
   a. At least 5 business days prior to the pre-meeting conference, the parties shall exchange their proposed exhibits and witness lists with copies to the Referee, in electronic form.
   b. The claimant's exhibits should be clearly marked in a numbered sequence (1,2,3…) while the Department's exhibits should be clearly marked in a lettered sequence (A, B, C…)
7. Pre-Meeting Order.

a. If any preliminary or procedural matters are discussed at the pre-meeting conference, the Referee will make written recommendations to the Chair for review and approval. Approved recommendations will be incorporated into a Pre-Meeting Order signed by the Chair. The Claims Committee may decide any preliminary or procedural matters at the beginning of the claims review meeting or reserve ruling until after the hearing has been completed.

8. Claim Review Meeting.

a. The Claims Committee will hold a claim review meeting attended by representatives of the contractor and the District.

b. The Chief Engineer may establish rules and procedures governing the claim review meeting. The Department will post such procedures on the Department's website and provided to the contractor after a notice of intent to file a claim is provided. These rules and procedures may be updated from time to time and updates will be posted on the Department's website and provided to any contractor who timely files a claim pursuant to this section.

c. The Claims Committee will schedule the claim review meeting within 60 calendar days after the District receives the contractor's appeal notice.

d. At the Claims Committee's sole discretion, the Claims Committee will notify the contractor if additional time is needed before conducting the claim review meeting.

e. A court reporter will record the proceedings of the claim review meeting.

f. The Department and the contractor will share the cost of the court reporter for the Claim Review meeting equally.

g. The Contractor is responsible to obtain and pay for a copy of the transcript from the court reporter.

h. A copy of the contract will form the record before the Claims Committee in addition to the claims, appeals, decisions, and documentation submitted in this process.

9. Preliminary Decision.

a. Within 45 calendar days after the claim review meeting, the Claims Committee will issue a preliminary written decision. The Claims Committee's preliminary written decision will include the money, time, or other relief, if any, that the Claims Committee concludes the contractor is due, and the reasons why the contractor is not entitled to the full amount of money, time, or other relief claimed.

b. In the Claims Committee's sole discretion, the Claims Committee will notify the contractor if it needs additional time to review the claim or prepare the committee's preliminary written decision.

10. Resolution Period and Final Decision.

a. After the Claims Committee issues its preliminary written decision, the contractor and the District have a period of 15 calendar days to attempt a negotiated resolution to the claim. If after 15 calendar days the parties have not negotiated a resolution to the claim, the Claims Committee will issue its final written decision. The District may extend this 15-day period at its sole discretion.

b. The contractor may appeal the Claims Committee's final written decision to the Secretary.

G. Secretary's Decision

1. Provide a written appeal notice to the Claims Committee chairperson within 10 calendar days after receiving the Claims Committee's final written decision.
2. Failure by the contractor to provide timely notice of an appeal constitutes a waiver of the right to appeal. The contractor's entitlement to compensation, an extension of contract time, or other relief is limited to the amounts set forth in the Claims Committee's written claim decision.
3. The Secretary will notify the parties, in writing, within 30 calendar days after receiving the written appeal notice that notice was received.
4. The Secretary may designate a representative to fulfil all, or a portion of, the Secretary's obligations associated with Section 105.15.G, Secretary's Decision.
5. The Secretary will review the record and may schedule a meeting or hearing with the parties to discuss the claim.
6. Within 90 calendar days of receipt of the contractor's appeal notice, The Secretary may meet with the contractor to present the results of the Secretary's claim evaluation. The Secretary and the contractor may attempt to reach agreement during the meeting and resolve all or part of the claim.
7. If the Secretary and the contractor are not able to resolve all or part of the claim, the Secretary will issue a written decision regarding the portion of the claim that was not resolved within 15 calendar days of the meeting. The decision will include the amount of money or time, if any, that the contractor is due, and the reasons why the contractor is not entitled to the full amount of money or time claimed.
8. At the Secretary's sole discretion, the Secretary will notify the contractor if additional time is needed to review the claim or prepare the Secretary's written decision.
9. If the contractor and the Secretary agree, the parties will engage in a facilitated, non-binding mediation.
10. If the parties agree to mediation, the Department will suspend all time limits until the mediation is completed.
11. The Secretary and the contractor will jointly decide the time and place for mediation and will jointly select a mediator.

12 The contractor and the Department will share mediator costs equally.

13. The contractor and the Department may conduct a mediation in addition to, or instead of, the Secretary's meeting with the contractor.
14. The parties may conduct the mediation in addition to the non-binding dispute resolution conducted at the District level.

H. Contractor, Subcontractor, and Supplier Disputes

Arbitration proceedings shall resolve disputes between the contractor and its subcontractors and suppliers concerning payments held in trust, as required by Chapter 8, Title 17 of the Delaware

Code. The Department will not serve as the arbiter of such disputes, but will, in the absence of agreement between the parties, designate the American Arbitration Association to resolve the matter.

105.16 Partial Acceptance; Project Acceptance; Final Acceptance; and Project Closeout.

A. Partial Acceptance.

1. The decision to partially accept a portion of the project is solely at the discretion of the engineer. The engineer may partially accept portions of the work. The Department will not consider partial acceptance as constituting acceptance of the work that has not been partially accepted or a waiver of any contract provisions. The Department will maintain the partially accepted portion of the project, including repairing damage caused by the public.

B. Project Acceptance.

1. The Department will cease counting contract time when the project reaches substantial completion as defined in Section 101.3, Definitions.
2. Initial (formerly referred to as Semi-Final) inspection.
   a. Upon receiving the contractor's notice of substantial completion of the project, the District will conduct an initial inspection. Following this inspection, the District will provide a written punch list, by stations and in detail, noting work or conditions requiring correction.
   b. Perform the corrective work noted on the punch list within 15 days unless the parties mutually agree to extend the time frame.
   c. After completion of the initial punch list to the Department's satisfaction, request a primary inspection from the Department.
   d. The Department will schedule the primary inspection within 30 calendar days of the request.
3. Primary Inspection.
   a. The District will conduct a primary inspection with the completion of 105.16.B.2 initial inspection. The District will note and provide a written punch list identifying work or conditions requiring correction.
   b. Perform the corrective work noted on the punch list within 30 days upon receipt of the punch list created by the administering section, unless the parties mutually agree to extend the time frame.
   c. Upon satisfactory completion of the corrective work noted during the primary inspection and provided on the primary inspection punch list, the Department will verify punch list completion within 30 days of completion of the punch list.
4. At the District's sole discretion, the District will notify the contractor if the District needs additional time.
5. If the contractor fails to complete punch lists within the time provided, the Department will assess liquidated damages in the amount of 10 percent of the value shown in Section 108.9, Schedule of Liquidated Damages, for each calendar day or working day, depending on the type of contract, counted beyond substantial completion date that exceeds the allowable contract

time. The engineer may extend this time as set forth in Section 108.7, Extensions of Contract Time.

C. Final Acceptance

1. The engineer will provide final acceptance in writing that will state the acceptance date as defined in Section 101.3, Definitions.

D. Project Closeout

1. Upon final acceptance, provide the exempted documents, certificates, or proofs of compliance within 90 calendar days.
2. The Department will not issue the final payment until the contractor executes and delivers the required documents.

SECTION 106 — MATERIAL QUALITY AND TESTING REQUIREMENTS

106.1 Source of Supply and Quality Requirements.

A. Use materials that meet the contract requirements.

B. Use only new materials unless otherwise specified in the contract.

C. Submit documentation requesting approval of material sources before delivery to the project. Submission requirements and instructions for source information are listed on DelDOT's website: https://deldot.gov/Business/prodlists/index.shtml.

1. If material requirements are not provided in the Standard Specifications or a Special Provision, submit all Plan sheets that contain relevant material requirements as documentation with the source of supply submission.

D. The Department will only allow one source of material to be used. An alternate source may be submitted. Sources cannot be combined.

E. Material approval varies based on the type and use of material. The Department approves materials based on:

1. Supply source verified by sample testing and analysis
2. Certification
3. Approved products lists

F. Obtain Department approval for all materials before use. Using unapproved materials is at the contractor's risk as the engineer may deem the unapproved materials unacceptable.

G. The Department's acceptance of a source, certification, or approved product does not constitute final acceptance. If materials do not meet the contract requirements at the jobsite before or after use, remove or correct the materials to comply with the contract.

106.2 Samples, Tests, and Referenced Specifications.

A. The engineer may inspect and test materials at any time before, during, or after use in the work. Tests performed by the engineer are for quality assurance and acceptance of the work. Material quality control is the contractor's responsibility as stated in Division 1000 of these specifications.

B. The Department will perform material tests in accordance with the Department of Highway (DOH), AASHTO, or ASTM test methods current on the date of the advertisement. When a specification or test is identified in the form of an AASHTO or ASTM number indicated as "modified," it refers to an AASHTO or ASTM specification or test modified by the Department's Materials Manual in effect on the date of advertisement. If there is a procedural difference in the DOH, AASHTO, or ASTM test methods, the Department will follow this order of precedence:

1. Materials Manual
2. AASHTO
3. ASTM

C. The engineer will set forth minimum requirements for material quality assurance sampling and testing on each contract. Ensure that the engineer has the access and time needed to perform the

sampling and testing. The engineer reserves the right to perform more than the minimum number of tests. The Department will make copies of any or all test results available to the contractor upon request.

D. When, in the engineer's judgment, the contract requires inconsequential quantities and use of materials, the Department may make a field inspection report of materials instead of following the minimum requirements for sampling materials.

106.3 Compliance Certification.

A. Use materials for the work designated in the contract or designated by the Department's Materials and Testing Schedule accompanied by manufacturer certificates of compliance. Provide certificates of compliance signed by the manufacturer stating that the materials or assemblies provided fully comply with the contract. Ensure that each lot of certified materials or assemblies has a certificate of compliance clearly identifying the materials delivered and the specification requirement satisfied.

B. The Department may sample and test materials or assemblies provided on the basis of certification of compliance. The Department will reject materials not in conformance with the contract in accordance with Section 105.11, Removal of Defective and Unauthorized Work.

C. Distribute the compliance certificates in accordance with the contract or the Department's Materials Manual.

106.4 Manufacturing Plant Inspection.

A. The Department may inspect manufacturing plants for compliance with specified manufacturing methods. The contractor and the material producer shall cooperate and assist the engineer. Provide the engineer with full access at any time to all parts of the plant manufacturing or producing the project materials.

B. The Department will take material samples to test for compliance with material quality requirements. Provide a laboratory conforming to the requirements of Section 106.5, Field Laboratory, located near the plant for the Department's use.

C. The Department may retest materials, previously tested at the supply source, when delivered to the project.

D. The material producer shall establish plant safety protocols that the contractor and the Department will follow.

E. Manufacturing plants shall comply with OSHA workplace requirements.

106.5 Field Laboratory.

Provide field laboratories in accordance with Section 612, Precast Concrete, for precast concrete items and Section 1014, Asphalt Materials Production, for bituminous asphalt.

106.6 Storage and Handling.

A. Store and handle materials to ensure fitness for the work and in a manner that facilitates inspection. The Department may inspect or test stored materials before use.

B. The contractor may use an approved portion of the right-of-way for material storage, to locate a contractor's plant, or to store equipment. Do not use private property for storage without written

permission of the property owner or lessee. The engineer may request copies of written permission to use private property for storage.

1. Do not store materials or equipment under or adjacent to DelDOT maintained bridges or retaining walls without an executed agreement.

C. Restore storage and plant sites to their original condition.

106.7 Unacceptable Materials.

The Department will reject materials not conforming to the contract requirements. Either remove rejected materials from the project or correct the material defects using methods approved by the engineer in accordance with Section 106.8, Disposal of Unacceptable Materials.

106.8 Disposal of Unacceptable Materials.

A. Waste materials from the work become the contractor's property. Remove the waste materials from the project.

1. The contract may provide disposal sites for the contractor's use. If the contract-provided disposal sites are not large enough to handle all contract waste materials, procure additional disposal sites as necessary.
2. Submit proposed disposal sites for the engineer's approval before using the sites.
   a. Provide a plan of the disposal area that includes:
      i. Includes sediment and erosion control devices.
      ii. Shows the existing contours and proposed final contours.
      iii. Contains a list of materials the contractor plans to place in the disposal area.
      iv. Details proposed security measures.
   b. When preparing and using off-site disposal areas, comply with all stormwater and environmental rules, regulations, or applicable permits issued by DNREC, USACOE, and all other applicable government agencies. Obtain permits, if necessary, in accordance with Section 107.2, Permits, Licenses, and Taxes.
   c. Costs for preparing these plans are incidental to the pay item that generates the waste.
   d. For disposal sites designated in the contract documents, the Department will pay for erosion and sediment controls, seeding, and mulching under applicable pay items.
   e. The Department will consider costs for erosion and sediment controls, seeding, and mulching for contractor-procured disposal sites as incidental to the pay items that generate the waste.

106.9 Department-Provided Material.

A. The Department will deliver, or make available, to the contractor Department-provided material at locations specified in the contract.

B. Include the cost of handling and placing Department-provided materials in the pay items the materials are used for. The Department will make deductions from monies due the contractor for damage that occurs to the material after delivery due to contractor negligence. The Department

will deduct money due the contractor should the Department incur unanticipated delivery costs because of contractor delays in accepting and unloading the materials.

SECTION 107 — LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.1 Laws to be Observed.

A. 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, 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.

B. If the contractor discovers 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.

107.2 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.

107.3 Patented Devices, Materials, and Processes.

The contractor and the surety shall hold and save harmless the State of Delaware, the Department, its secretary, and all officers, agents, and servants, 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.

107.4 Contractor's Responsibility to Protect Utility Property and Services.

A. 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.

B. 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.

C. 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.

D. Whenever any work is performed in the area of a fire hydrant or whenever a fire hydrant is relocated or installed, maintain the center of the hose outlet 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.

107.5 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 is 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.

107.6 Construction Safety, Health, and Sanitary Standards.

A. Do not require any person employed in performance of the contract to work in surroundings or under working conditions that are unsanitary, hazardous, or dangerous to such person's health or safety. Expressly state this requirement in each subcontract agreement.

B. Provide and maintain in a neat and sanitary condition such accommodations for the use of its employees as necessary to comply with the requirements of the state and local boards of health, or of other bodies or tribunals having jurisdiction.

107.7 Public Convenience and Safety.

A. 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 on the highway in accordance with the DE 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 crossings of intersecting highways. Do not obstruct sidewalks, gutters, sewers, inlets, or portions of the highway adjoining the roadways under construction more than is absolutely necessary to complete the work.

B. 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 the Department may use State maintenance forces or a third party contractor to make such repairs. The Department will calculate the cost for this work in accordance with Section 109.4.D, Force Account, for all State personnel involved or third party contractors, including vehicles, equipment, and materials needed. The Department will deduct this cost 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.

107.8 Use of Explosives.

A. 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. The contractor assumes responsibility for all damage resulting from the use of explosives.

B. 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 1,000-feet from the road or from any building or camping area or place of human occupancy.

C. Do not store explosives overnight on the project.

D. 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.

E. The Department will not permit use of explosives within 200-feet of any existing, newly finished, or partly finished structure on a project unless authorized in writing by the engineer.

F. Follow the requirements of the DE MUTCD for blasting zone operations.

107.9 Protection and Restoration of Property.

A. Assume responsibility for the preservation of all public and private property, along and adjacent to the roadway not designated on the plans for repair, removal, or construction. Take the precautions necessary to prevent damage to trees, plantings, pipes, conduits, and other underground structures. Do not injure or destroy trees or plantings outside the LOC, nor remove or cut them without proper authority.

B. Protect from disturbance or damage all land monuments and property markers. 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.

C. 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, the contractor shall restore such property at the contractor's expense to a condition similar or equal to that existing before such damage.

D. 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 will deduct the cost thereof from any monies due to the contractor under the contract.

107.10 Responsibility for Damage Claims.

A. The contractor shall assume the responsibility and liability for, and indemnify and save harmless the State of Delaware, the Department of Transportation, its Secretary, and all officers, agents, employees, assigns, and servants 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 is not 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:

1. 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.

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

3. 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 the Department will not withhold such money when the contractor produces satisfactory evidence that it is adequately protected by public liability and property damage insurance. In any event, the surety is 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 is responsible for securing all necessary rights-of-way in advance of construction. The Department will note any exceptions 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.

A. Upon completion of the work, the Department will accept the work in accordance with Section 105.16, Partial Acceptance; Project Acceptance; Final Acceptance; and Project Closeout. 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 is not held to be a waiver of any other or subsequent breach.

B. 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.

A. 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.

B. 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.

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

107.15 Audits.

A. The Department may examine and audit the following items for at least 3-years after the contractor's acceptance of final payment as set forth in Section 109.12, Source of Supply and Carrier Rates on Construction Materials.

1. Books
2. Records
3. Documents
4. Accounting procedures
5. Accounting practices

B. The Department may examine and audit these items for the contractor, its subcontractors, and its suppliers at every tier. If the contractor is a joint venture, also make these items available for examination and audit from the contractor’s joint venture partners.

C. The specific items to be made available for audit include at a minimum all the records listed in Section 105.15.C.2, even if these records have already been provided to the Department.

D. The contractor waives entitlement to compensation, an extension of time, or other relief for itself and its subcontractors, vendors, and suppliers if the records identified by the Department are not made available to the Department for examination and audit.

E. The Department will provide the contractor with reasonable notice, but not less than 15-days, before conducting the audit.

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

108.1 Contract Subletting.

A. Perform no less than 50 percent of total original contract price with the contractor's own organization, excluding designated specialty items. The Department will allow the contractor to perform specialty items by subcontract. The Department may deduct the amount of specialty items, performed by subcontractors, from the total original contract price before calculating the amount of work the contractor plans to perform using the contractor's own organization. The contract price that the Department will use as a basis to calculate the 50 percent requirement includes the cost of material and manufactured products that the contractor plans to purchase or produce. The Department will not require an adjustment of the calculated percentage due to adjustments in quantities or added or extra work.

1. The cost of flagging operations, including overtime rates, when performed by others who are not the Contractor's employees, will not be included in the 50 percent subcontracting limit.

B. The term "subcontractors" as used in the previous paragraph, does not include suppliers that deliver and deposit, but do not incorporate, material; suppliers or services that transport material; and work performed that does not physically advance the completion of the contract and is not considered as an item of work.

C. The term "the contractor's own organization" refers to workers employed by or leased by the contractor and equipment owned or rented by the contractor with or without operators. The term does not include subcontractor employees or equipment, agents of the contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm if the contractor:

1. Controls the day-to-day activities of leased employees;
2. retains responsibility for the quality of work performed by leased employees;
3. retains all power to accept or exclude individual employees from work on the project; and
4. remains responsible for payment of predetermined minimum wages, payroll submissions, compliance statements, and all other federal regulatory requirements.

D. The Department will identify the specialty items in the contract.

E. Do not sublet, sell, transfer, assign or otherwise dispose of any portion of the contract without the engineer's written consent. Consent, when given, does not relieve the contractor its responsibility to fulfill the contract requirements. Do not provide work or materials from an organization other than the contractor's own, or otherwise dispose of the contract or contracts or any portion thereof, or of its right, title or interest therein, without written consent from the engineer. The engineer will only provide written consent after assurance that each subcontract is in writing and that it contains the pertinent provisions and requirements of the contract.

F. Outline the scope and value of work the contractor proposes to subcontract. If requested by the engineer, detail the cost of the materials included in the subcontractor's work. Include the cost of subcontractor materials in the value of the subcontracted work. Obtain the engineer's written permission before allowing a subcontractor to subcontract a portion of subcontracted work. In granting such permission, the engineer will require that the subcontractor seeking to subcontract

a portion of its subcontract to perform no less than 50 percent of its subcontract with the subcontractor using its own organization.

G. Perform traffic control work and related items with labor, equipment, and materials from the contractor's own organization and a single subcontractor unless approved by the engineer.

H. When the contractor subcontracts a portion of the contract to a subcontractor, the Department will apply the subcontractor payment to fulfill the Disadvantaged Business Enterprise (DBE) contract requirements if the subcontractor is a DBE. 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.

I. Submit certified copies of subcontractor agreements and copies of the subcontractors' Delaware business licenses as a prerequisite to payment for work performed by a subcontractor, or on a subcontractor's behalf. Submit the information before a subcontractor performs work on the project. Submit contracts with suppliers or any other person, firm, or organization that will perform work on the project for review and approval by the engineer. Ensure that each subcontract clearly states that all provisions and requirements of the contract are included in the subcontract.

J. The Department may also require the contractor to submit additional information concerning the prospective subcontractor or supplier. This information may include any required by the contract, by the Department, by the FHWA, or by other governmental agencies. This information may include:

1. Evidence that the organization that performs the work is experienced and equipped for such work.
2. Assurance by the contractor that the labor standards provisions set forth in this contract apply to labor performed on all work encompassed by the contract.
3. Assurance that all civil rights provisions and DBE requirements have been satisfied.

J. Include the following provisions in all subcontracts:

1. Indemnification language that saves harmless the Department from the actions of the subcontractors or suppliers;
2. provisions that provide for the binding arbitration of all disputes between the parties to the subcontract agreements; and
3. provisions that save harmless and indemnify the Department for omissions in the subcontract agreement.

K. Do not interpret Department reviews, permissions, or granted approvals under these specifications as approval of the work a subcontractor performs or of material provided by a supplier. Such reviews, permissions, or approvals by the Department do not relieve the contractor of the sole responsibility for satisfactory completion of the contract. 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.

L. The Department may refuse to pay for, or accept, all or part of the work or materials supplied by a subcontractor or materials supplier the contractor failed to submit to the Department for

approval or by a subcontractor or material supplier that the contractor did submit that the Department did not approve.

108.2 Preconstruction Meeting; Submitting a Schedule; Notice to Proceed.

Following contract execution, the engineer may schedule a preconstruction meeting. Before the preconstruction meeting, submit the progress schedule in accordance with Section 108.4, Progress Schedule. After the preconstruction meeting, the engineer will issue the contractor a notice to proceed that will stipulate the contract start date. The Department will set the contract start date at least 10 calendar days after the date the Department issues the notice to proceed. The contractor may begin work upon receipt of the notice to proceed. The Department will not require the contractor to wait 10 days to begin work. Contract time will begin on the day that work starts or on the date stipulated in the notice to proceed, whichever is earlier.

108.3 Commencement of Work; Counting Contract Time.

A. Begin work no later than the date stipulated in the notice to proceed. The Department will count contract time using either calendar days or working days in accordance with the bid proposal.

B. For calendar day contracts, the Department will begin contract time in accordance with Section 108.2, Preconstruction Meeting; Submitting a Schedule; Notice to Proceed, and continue counting every day shown on the calendar until substantial completion as determined by the engineer. The Department will not allow work on Sundays or holidays unless the engineer determines that working on Sundays or holidays is in the best interest of the Department. Submit a written request to the engineer to work on a Sunday or holiday, if there is a reason to work those days. Submit the request to work at least 3 business days before the Sunday or holiday planned for work. Provide notice to the engineer no later than 12:00 PM on a Friday if the contractor plans to work the following day.

C. For working day contracts, the Department will begin contract time in accordance with Section 108.2, Preconstruction Meeting; Submitting a Schedule; Notice to Proceed, and continue as defined in Section 101.3, Definitions, until substantial completion of the work as determined by the engineer. The Department will not allow work 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 to work on a Sunday or holiday, if there is a reason to work those days. Submit the request to work at least 3 business days before the Sunday or holiday planned for work. Provide notice to the engineer no later than 12:00 PM on a Friday if the contractor plans to work the following day.

108.4 Progress Schedule.

A. General.

1. Definitions.

a. Activity. A discrete, identifiable task or event that takes time, has a definable start and finish date, furthers the work progress, and is used to plan, schedule, and monitor the project.

b. Activity, Critical. An activity on the critical path.

c. Activity, Near-Critical. An activity with a total float value within 30 working days of the float on the critical path.

d. Activity ID. A unique, alphanumeric, identification code assigned to an activity.

e. Constraints. A restriction imposed on the start or finish date of an activity.

f. Critical Path. The longest work path that forecasts the project's substantial completion date. After the contractor achieves substantial completion, the critical path is the longest work path that forecasts the project acceptance date as that date is defined in Section 105.16, Project Acceptance; Partial Acceptance. Milestones also have critical paths defined as the longest work path that forecasts the completion of the milestone.

g. Data Date. The date the schedule is calculated from.

h. Duration, Original. The estimated time, expressed in workdays, needed to perform an activity.

i. Duration, Remaining. The estimated time, expressed in workdays, needed to complete an activity.

j. Early Completion Schedule. A progress schedule that forecasts achievement of the substantial completion date prior to the substantial completion date established by the contract.

k. Float. The amount of time an activity or work path can be delayed and not delay the substantial completion date. After the contractor achieves substantial completion, float is the amount of time an activity or work path can be delayed and not delay the project acceptance date as that date is defined in Section 105.16, Partial Acceptance; Project Acceptance; Final Acceptance; and Project Closeout.

l. Float, Sequestered. Float hidden in activity durations or consumed by unnecessary or overly restrictive logic.

m. Float, Total. The difference calculated in working days between an activity's early and late dates.

n. Lag. An amount of time, measured in working days, between the date when an activity starts or finishes and the date when its successor activity can start or finish.

o. Milestone. An activity with no duration that is typically used to represent the beginning or end of the project or its interim stages.

p. Written Narrative. A descriptive report submitted with each schedule.

q. Open End. The condition that exists when an activity has either no predecessor or no successor. Only the first and last activities are allowed to have open ends. The first activity will have no predecessor and the last activity will have no successor.

r. Predecessor. An activity that is defined by schedule logic to precede another activity. A predecessor may control the start or finish date of its successor.

s. Relationship. The interdependence among activities. Relationships link an activity logically to its predecessors and successors.

t. Schedule, Baseline. The approved critical path method (CPM) schedule showing the original plan to complete the entire project.

u. Schedule, Baseline Barchart. The approved initial barchart schedule showing the original plan to complete the entire project.

v. Schedule, Bi-weekly Look Ahead Barchart. A bi-weekly update of the baseline barchart schedule or the previous bi-weekly look ahead barchart schedule that depicts the work that is expected to occur during the following 2-weeks.

w. Schedule, Initial Baseline. The CPM schedule showing the original, detailed plan for the first 60 calendar days of project duration.

x. Schedule, Monthly Update. A schedule produced by incorporating the project's actual progress on a monthly basis into the baseline schedule, the previous monthly update schedule, or revised schedule.

y. Schedule, Progress. An initial barchart schedule, a baseline barchart schedule, a bi-weekly lookahead barchart schedule, a revised barchart schedule, an initial baseline schedule, a baseline schedule, a monthly schedule update, or a revised schedule.

z. Schedule, Revised. A schedule prepared and submitted by the contractor that includes a significant modification to the schedule logic or durations.

aa. Schedule, Revised Barchart. A barchart schedule prepared and submitted by the contractor that includes a significant modification to the schedule logic or durations.

bb. Schedule, Final. The last schedule update containing actual start and finish dates for every activity.

cc. Successor. An activity that is defined by schedule logic to succeed another activity.

2. Requirements.

a. Prepare the progress schedule in accordance with Sections 108.4.B.2, Barchart Schedules, 108.4.C.2, Type 1 CPM Schedules, or 108.4.D.2, Type 2 CPM.

b. Provide a progress schedule that depicts how the contractor plans to execute the work.

c. Include activities for the contractor, the Department, subcontractors, vendors, suppliers, utilities, railroads, government agencies or authorities, and other parties involved with the project.

d. Use the progress schedule to plan, schedule, and coordinate the work.

e. The engineer's approval of a portion of the progress schedule or an incomplete schedule submittal does not constitute approval of the entire schedule.

f. If the engineer approves a progress schedule, the engineer will provide the contractor with such approval in writing.

g. The engineer's approval of a schedule does not:

i. Change the contract;

ii. constitute the Department's endorsement or validation of the contractor's schedule logic, activity durations, or assumptions;

iii. transfer the contractor's responsibilities to the Department; the contractor alone shall remain responsible for adjusting forces, equipment, and work schedules to ensure completion of the work within the contract time;

iv. guaranty that the contractor can perform the work as scheduled; or

v. waive the contractor's obligation to provide notice in accordance with Section 104.3, Notification of Contract Changes.

h. If the contractor or the engineer discovers an error after the engineer approves the schedule, correct the error in the next schedule submission.

i. The engineer may withhold payment of the Initial Expense pay item until the initial barchart schedule or initial baseline schedule is approved.

j. Incorporate weather into the progress schedule. The contractor may include weather by providing weather days in the schedule calendar or by increasing activity durations. The Department will not allow the contractor to include time for weather in the form of a weather activity at the end of the scheduled work or by distributing weather activities throughout the schedule.

k. Identify State of Delaware holidays in the schedule as non-workdays in the schedule calendar.

l. Ensure that the project schedule complies with maintenance of traffic restrictions.

3. Early Completion.

a. The Department allocates its resources to a contract based on the contract time. The engineer may approve an early completion schedule, but the Department cannot guaranty it will have the resources available to support the contractor's early completion schedule. The Department will consider delays to the contractor's early completion schedule resulting from the Department's inability to support the schedule as non-excusable and non-compensable.

b. If the engineer approves an early completion schedule, the Department will classify the time between the scheduled early substantial completion date and the contract substantial completion date as float.

c. If the contractor experiences an excusable, non-compensable delay that does not delay the scheduled substantial completion date to a date later than the contract substantial completion date, the contractor is not entitled to a time extension for such delays.

d. If the contractor experiences an excusable, compensable delay that does not delay the scheduled substantial completion date to a date later than the contract substantial completion date, the contractor is not entitled to a time extension or compensation for the delay.

4. Float Ownership and Sequestered Float.

a. Float is a shared commodity available to the project and is not for the exclusive use of any party.

b. Do not sequester float. Examples of prohibited float sequestration include:

i. Relationships between unrelated activities.

ii. Overly restrictive relationships between activities.

iii. Activities with excessively long durations.

B. Barchart Schedules.

1. General.

a. Submit a barchart schedule, unless a pay item is provided in the bid proposal for a CPM schedule.

b. Include barchart activities that show:

i. Essential work features;

ii. procurement, including submittals that require engineer review time;

iii. third party activities related to the contract;

iv. all work completing within the contract time; and

v. the critical path; the Department understands that the critical path through a barchart schedule is based on judgment and not on computer analysis.

2. Baseline Barchart Schedule.

a. At least 7 calendar days before the preconstruction meeting, submit the baseline barchart schedule to the engineer.

b. Within 7 calendar days of receipt of the baseline barchart schedule, the engineer will respond by either approving the schedule, rejecting the submission and identifying the reasons for rejection, or asking for more information.

c. Include the entire project scope of work in the baseline barchart schedule.

d. Use the notice-to-proceed date as the data date of the baseline barchart schedule. If the notice-to-proceed date is not known, then use an assumed date until the actual notice-to-proceed date is known.

e. Do not show actual progress in the baseline barchart schedule.

f. For the first resubmittal and all subsequent resubmittals, re-submit the corrected baseline barchart schedule addressing all of the Engineer's comments within 7 calendar days of receiving the comments.

g. The engineer will respond within 7 calendar days of receipt of the resubmitted baseline barchart schedule by approving the baseline barchart schedule, rejecting the baseline barchart schedule and identifying the reason(s) for rejection, or asking for more information.

3. Bi-Weekly Look Ahead Barchart Schedule.

a. Submit a bi-weekly look ahead barchart schedule depicting the work planned for the next 2-week period. The engineer will identify the day of the week for submission of the bi-weekly look ahead barchart schedule.

b. Include within the bi-weekly look ahead barchart schedule the description, duration, and sequence of work activities, along with the planned hours of work for the next 2-week period.

c. Base the bi-weekly look ahead barchart schedule on the approved baseline barchart schedule or the approved revised barchart schedule.

4. Revised Barchart Schedule.

a. The engineer may request a revised barchart schedule when any one of the following events occur:

i. There is a change that affects the critical path;

ii. the actual sequence of work is different from that in the approved baseline barchart or revised schedules;

iii. the scheduled substantial completion date is delayed to a date more than 10 calendar days later than the contract substantial completion date; or

iv. the engineer extends the contract time.

b. Include the following in the revised barchart schedule:

i. The actual durations and sequence of completed work activities;

ii. modifications to the sequence or durations of remaining activities; and

iii. approved time extensions.

c. Show the completion of all remaining work within the remaining contract time in the revised barchart schedule.

d. Submit the revised barchart schedule within 7 calendar days of receiving a written request from the engineer.

e. The engineer will respond within 7 calendar days by approving the revised barchart schedule, rejecting the schedule and identifying the reasons for rejection, or asking for more information.

C. Type 1 CPM Schedules.

1. Type 1 CPM Schedule Requirements.

a. Prepare and submit a Type 1 CPM schedule when a pay item for this schedule type is provided in the bid proposal.

b. In addition to the requirements of Section 108.4.A., General, prepare a Type 1 CPM schedule that complies with each of the following requirements:

i. Ensure that native electronic CPM schedule files submitted to the engineer will import completely and accurately into the Oracle Primavera Unifier Software used by the Department. Provide native files in the XML format.

ii. Use the following schedule settings:

(1) Calculate total float using finish float;

(2) select critical activities as the longest path;

(3) use the retained logic scheduling option;

(4) use project-level calendars, not global or resource calendars; and

(5) use project-level codes, not global- or EPS-level codes.

iii. Do not use user-defined fields.

iv. Ensure that each activity:

(1) Possesses a unique activity description composed of a verb, object, and location;

(2) has at least 1 predecessor activity except for the first activity in the schedule;

(3) has at least 1 successor activity except for the last activity in the schedule;

(4) uses only finish-to-start relationships unless otherwise authorized in writing by the engineer; and

(5) does not contain activity lags unless authorized in writing by the engineer.

v. Use only task dependent, start milestone, and finish milestone activity types.

vi. At a minimum, include CPM schedule activities that show:

(1) Notice-to-Proceed;

(2) mobilization;

(3) essential work features;

(4) procurement, including submittals that require engineer review time;

(5) third party activities related to the contract;

(6) substantial completion;

(7) all work completing within the contract time; and

(8) the critical path.

vii. Use project-specific activity codes in place of WBS.

viii. Assign each activity to one of the project-specific calendars as identified in the following Table.

Table 108.4-1. Acceptable CPM Schedule Activity Calendars.

Calendar Name	Non-workdays
Standard 5-day workweek	Weekends and holidays
7-day workweek	None

ix. Obtain the engineer's written authorization before using activity calendars other than those listed in Table 108.4-1.

x. Use the schedule file naming convention depicted in the following Table 108.4-2. If the schedule submission is not approved, name the resubmitted files as shown in the table. The ####-### indicates a placeholder for the State Project Number.

Table 108.4-2. CPM Schedule Filename Convention.

Schedules	1st Version	2nd Version	3rd Version
Baseline Schedule (All Schedules until it is Accepted as Baseline)	####-###-BASE-1	####-###-BASE-2	####-###-BASE-3
1st schedule update	####-###-UP01		
2nd schedule update, etc.	####-###-UP02		
1st revised schedule	####-###-RS01-1	####-###-RS01-2	####-###-RS01-3
1st Update to revised schedule, etc.	####-###-RUP01		

2. Baseline Type 1 CPM Schedule.

a. At least 7 calendar days before the preconstruction meeting, submit the baseline Type 1 CPM schedule to the engineer.

b. Within 7 calendar days of receipt of the baseline Type 1 CPM schedule, the engineer will respond by either approving the schedule, rejecting the submission and identifying the reasons for rejection, or asking for more information.

c. Include the entire project scope of work in the baseline Type 1 CPM schedule.

d. Use the notice-to-proceed date as the data date of the baseline Type 1 CPM schedule. If the notice-to-proceed date is not known, then use an assumed date until the actual notice-to-proceed date is known.

e. Do not show actual progress in the baseline Type 1 CPM schedule.

f. For the first resubmittal and all subsequent resubmittals, re-submit the corrected baseline Type 1 CPM schedule addressing all of the Engineer's comments within 7 calendar days of receiving the comments.

3. The engineer will respond within 7 calendar days of receipt of the resubmitted baseline Type 1 CPM schedule by approving the baseline Type 1 CPM schedule, rejecting the baseline Type 1 CPM schedule and identifying the reason(s) for rejection, or asking for more information.

D. Type 2 CPM.

1. Type 2 CPM Schedule Requirements.

a. Prepare and submit a Type 2 CPM schedule when a pay item for this schedule type is provided in the bid proposal.

b. In addition to the requirements of Section 108.4.A., General, prepare a Type 2 CPM schedule that complies with good scheduling practice as described in the most current edition of the AGC's Construction Planning & Scheduling Manual and each of the following requirements. If the AGC's manual conflicts with the contract, the contract takes precedence:

i. Ensure that native electronic CPM schedule files submitted to the Engineer will import completely and accurately into the Oracle Primavera Unifier Software used by the Department. Provide native files in the XML format.

ii. Use the following schedule settings:

(1) Calculate total float using finish float;

(2) select critical activities as the longest path;

(3) us the retained logic scheduling option;

(4) use project-level calendars, not global or resource calendars; and

(5) use project-level codes, not global- or EPS-level codes.

iii. Do not use user-defined fields.

iv. Ensure that each activity:

(1) Possesses a unique activity description composed of a verb, object, and location;

(2) has a duration expressed in no more than 20 working days unless otherwise authorized in writing by the engineer;

(3) has at least 1 predecessor activity except for the first activity in the schedule;

(4) has at least 1 successor activity except for the last activity in the schedule;

(5) uses only finish-to-start relationships unless otherwise authorized in writing by the engineer; and

(6) does not contain activity lags unless authorized in writing by the engineer.

v. Use only task dependent, start milestone, and finish milestone activity types,

vi. Include no more than 20 percent critical activities and no more than 30 percent near-critical activities, unless otherwise authorized in writing by the Engineer.

vii. At a minimum, ensure that the CPM schedule includes activities for the following items:

(1) Notice-to-Proceed;

(2) mobilization;

(3) project milestones such as phase and traffic switch start or finish dates specified in the contract and availability dates specified in the contract;

(4) submittal, review, and approval activities, including time periods for the engineer's approval activities using approval durations in accordance with the contract;

(5) fabrication, delivery, installation, testing, and similar activities for materials, plants, and equipment;

(6) earth settlement or surcharge periods;

(7) utility notification and relocation;

(8) right-of-Way acquisitions;

(9) durations for receipt of permits;

(10) all construction work;

(11) substantial completion; and

(12) project completion.

viii. Use only "Finish on or Before" activity constraints and apply only to contract-required milestones or completion dates, unless otherwise authorized in writing by the engineer.

ix. Use project-specific activity codes in place of WBS.

x. Ensure that each activity is assigned an activity code value for each of the following activity codes. Examples of acceptable activity code values for each of the activity codes are listed below each mandatory activity code:

(1) Phase (for example)

- Phase 1
- Phase 2
- Phase 3

(2) Stage (for example)

- Stage 1
- Stage 2
- Stage 3

(3) Responsibility (for example)

- Name of general contractor

- Department
- Names of Subcontractors

(4) Location (for example)

- Station 100+00 to 110+00
- Station 110+00 to 120+00
- East Abutment
- West Abutment

(5) Work type (for example)

- Concrete
- Drainage
- Earthwork

(6) Crew (for example)

- Electrical subcontractor
- Earthwork Crew 1
- Earthwork Crew 2

xi. Assign each activity to one of the project-specific calendars as identified in the following Table 108.4-3.

Table 108.4-3. Acceptable CPM Schedule Activity Calendars

Calendar Name	Non-workdays
Standard 5-day workweek	Weekends and holidays
7-day workweek	None

xii. Obtain the engineer's written authorization before using activity calendars other than those listed in Table 108.4-3.

xiii. Use the schedule file naming convention depicted in the following Table 108.4-4. If the schedule submission is not approved, name the resubmitted files as shown in the table. The ####-### indicates a placeholder for the State Project Number.

Table 108.4-4. CPM Schedule Filename Convention

Schedules	1st Version	2nd Version	3rd Version
Baseline Schedule (All Schedules until it is Accepted as Baseline)	####-###-BASE-1	####-###-BASE-2	####-###-BASE-3
1st schedule update	####-###-UP01		
2nd schedule update, etc.	####-###-UP02		
1st revised schedule	####-###-RS01-1	####-###-RS01-2	####-###-RS01-3
1st Update to revised schedule, etc.	####-###-RUP01		

xiv. Eliminate instances of out-of-sequence progress on the critical path and near-critical paths in monthly schedule updates and revised schedules.

2. Scheduling Representative.
   a. Designate a scheduling representative before submitting the baseline schedule.
   b. Submit the scheduling representative's qualifications to the engineer for approval.
   c. Propose a scheduling representative with at least 3-years of verifiable experience preparing and maintaining CPM project schedules on contracts of similar size and complexity.
   d. The engineer's approval of the scheduling representative is required before the engineer will accept the baseline schedule.
   e. Replacement of the scheduling representative requires the engineer's written approval.
   f. The scheduling representative is:
      i. The person primarily responsible for development and maintenance of the CPM schedule;
      ii. the contractor's representative in all matters that concern the schedule;
      iii. the contractor's designated attendee to schedule-related meetings; and
      iv. the scheduling representative shall know the status of work throughout the project's duration.
3. Initial Baseline Schedule.
   a. The engineer will use the initial baseline schedule to monitor progress until the engineer approves the baseline schedule.
   b. Submit a written request to the contractor to waive the requirement for an initial baseline schedule and provide the baseline schedule instead. Submit the baseline schedule in accordance with the time limits of the initial baseline schedule. The engineer will review the baseline schedule in accordance with the time limits for the baseline schedule.
   c. The initial baseline schedule is a detailed CPM schedule, prepared to the same standards as the baseline schedule, but only for the first 60-days of the project.
   d. The contractor may use summary level activities with durations greater than 20-workdays depicting the work after the first 60-days.
   e. Establish the data date of the initial baseline schedule as the project's anticipated notice-to-proceed date.
   f. Do not include actual progress in the initial baseline schedule.
   g. At least 7 calendar days before the preconstruction meeting, submit the initial baseline schedule to the engineer for review.
   h. The engineer will respond within 14 calendar days by approving the initial baseline schedule, rejecting the schedule and identifying the reason for rejection, or asking for more information.
4. Baseline Schedule.
   a. Include the entire scope of work in the baseline schedule.

b. Ensure that the first 60-days of work depicted in the baseline schedule are identical to the first 60-days of work depicted in the initial baseline schedule.

c. Provide a baseline schedule that is a detailed CPM schedule for the entire project duration.

d. Use the project's notice-to-proceed date as the baseline schedule data date.

e. Do not include actual progress in the baseline schedule.

f. Within 30 calendar days of the preconstruction meeting, submit the baseline schedule to the engineer for review. The engineer will respond within 21 calendar days of receipt of the baseline schedule by approving the baseline schedule, rejecting the baseline schedule and identifying the reasons for rejection, or asking for more information.

g. Submit the first resubmittal and all subsequent resubmittals of the corrected baseline schedule addressing the engineer's comments within 7 calendar days of receiving the engineer's comments.

h. The engineer will respond within 7 calendar days of receipt of the resubmitted baseline schedule by approving the baseline schedule, rejecting the baseline schedule and identifying the reasons for rejection, or asking for more information.

E. Type 1 and Type 2 CPM Monthly Schedule Updates.

1. Submit monthly schedule updates every month after approval of the baseline schedule.

2. Provide the first monthly schedule update as an update of the baseline schedule with a data date coordinated with the date of the pay estimate.

3. Submit monthly schedule updates on the same business day each month.

4. Before submitting the monthly schedule update each month, meet with the engineer to review and agree on the progress achieved in the previous month. Show the progress agreed upon in the meeting in the monthly schedule update. Include actual start dates, actual finish dates, and the new remaining durations for activities that show as started and continuing.

5. Other than updating for actual progress, minimize the number of revisions to the monthly schedule update. Describe the reason for changes to the schedule in the written narrative submitted with the monthly update schedule.

6. The engineer has the authority to reject revisions made to the monthly schedule update.

7. Submit monthly schedule updates within 10 calendar days of the schedule data date.

8. The engineer will respond within 10 calendar days of receipt of the monthly schedule update by approving the monthly schedule update, rejecting the monthly schedule update and identifying the reason for rejection, or asking for more information.

9. Continue to submit monthly schedule updates even if the engineer has not approved the previous monthly schedule update.

10. The requirements for the monthly schedule updates are, other than these requirements, the same as for the baseline schedule.

F. Type 1 and Type 2 CPM Revised Schedule.

1. Do not perform work in a sequence or durations substantially different from the sequence and durations depicted on the approved baseline schedule or monthly schedule updates.

2. Submit a revised schedule if one of the following occurs:
   a. The contractor decides to substantially deviate from the sequence or durations of planned work in the current monthly schedule update;
   b. the engineer asks the contractor to show how it will recover a forecast completion date that is delayed more than 14 calendar days from the dates established by the contract time;
   c. the engineer concludes that there is a substantial difference between the actual sequence or actual duration of the work, and the work as depicted in the monthly schedule update;
   d. the issuance of a change order revises the planned sequence of work or the method and manner of its performance;
   e. the engineer extends the contract time; or
   f. there are significant changes to the critical path or near-critical paths.
3. A contractor shall not interpret a Department directive to prepare a revised schedule as a directive to accelerate the work.
4. If the engineer requests a revised schedule, submit the revised schedule within 7 calendar days of the request.
5. The engineer will respond within 10 calendar days of receipt of a revised schedule by approving the revised schedule, rejecting the revised schedule and identifying the reasons for rejection, or asking for more information.
6. The requirements for the revised schedule are, other than these requirements, the same as the baseline schedule.

G. Type 1 and Type 2 CPM Schedule Submission Requirements.

1. Provide a written narrative for each schedule submittal in accordance with the following:
   a. For the initial baseline, baseline, and revised schedules, provide:
      i. An explanation of the overall plan to complete the project, including where the work will begin and how work and crews will flow through the project;
      ii. the working days per week, number of shifts per day, number of hours per shift, the holidays anticipated by the contractor, and how the schedule anticipates weather days;
      iii. a statement describing the status of required permits;
      iv. a description of the number of crews and planned production rates for critical activities and near-critical activities;
      v. a list of activities requiring coordination with the Department or third parties, such as utilities;
      vi. a statement identifying constraints and an explanation of the purpose of each constraint;
      vii. a statement describing the reason for the use of each lag; and
      viii. a list of the key limited equipment or labor resources.
   b. For monthly schedule updates and revised schedules, provide:

i. The status of the contract completion dates compared to the contract-required dates and compared to the dates forecast in the previous schedule submission;

ii. a statement explaining why the contract completion dates are forecast to occur before or after the dates established based on the contract time;

iii. a description of the reasons for the schedule revisions;

iv. a statement describing the status of permits;

v. a description of the status of activities requiring coordination with the Department or third parties, such as utilities;

vi. a description of unusual labor, shift, equipment, or material conditions or restrictions encountered or anticipated since the previous schedule submission;

vii. a statement identifying new or revised constraints and an explanation of the reasons for the revisions; and

viii. a statement describing the reason for the use of new or revised lags.

2. Gantt Charts.

a. Provide the following Gantt chart printouts in .pdf format with each CPM schedule submission:

i. An “All Activities Printout” showing all activities grouped by phase, stage, and location, with the critical path activities shown in red;

ii. a “Critical Path Printout” showing the critical path to substantial completion;

iii. a “Near-Critical Printout” showing all near-critical activities grouped by total float values; and

iv. any other CPM schedule printouts requested by the engineer.

3. Gantt Chart Printout Information.

a. Ensure that each Gantt chart printout contains the following columns:

i. Activity ID;

ii. activity Name;

iii. original duration (OD);

iv. remaining duration (RD);

v. start;

vi. finish; and

vii. total float.

b. The schedule shall also show a title block with the following:

i. Data date;

ii. run date; and

iii. CPM schedule name.

H. Method of Measurement

1. The Department will consider the cost of providing a bar chart project schedule as incidental to the contract.
2. The Department will consider CPM baseline schedules as complete and ready for payment when the engineer approves the initial baseline and baseline schedules. The Department will pay the lump sum amount in the proposal.
3. The Department will consider CPM monthly update schedules, revised schedules, or the schedule incorporating a time impact analysis as required by Section 108.7, Extensions of Contract Time, as complete and ready for payment when the engineer approves the schedule. The Department will pay the lump sum amount in the proposal for schedule updates, for revised schedules, and schedules incorporating a time impact analysis as required by Section 108.7, Extensions of Contract Time, after the engineer's approval.

I. Basis of Payment

ITEM	DESCRIPTION	UNIT
763001	Baseline Schedule (Type 1)	LS
763002	Monthly Update Schedule (Type 1)	Each
763003	Baseline Schedule (Type 2)	LS
763004	Monthly Update Schedule (Type 2)	Each

108.5 Traffic Requirements and Contractor's Operations; Completing Work.

Schedule and conduct work to ensure the least interference with traffic. Do not open up work to the prejudice or detriment of work already started. The engineer may require the contractor to finish a section work in progress before starting work on any additional sections.

108.6 Preference for Delaware Labor; Character of Workers and Equipment; Specified Construction Methods.

A. 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 a penalty to the Treasurer of the State of Delaware equal to the amount of compensation paid to any person in violation. The requirement to give preference to Delaware laborers, workers, or mechanics will not apply to federally funded contracts.

B. If the engineer decides an employee is careless, incompetent, or obstructs the progress of the work, discharge the employee upon the engineer's request. Do not employ that person on the contract or any other DelDOT contract, without the engineer's written consent.

C. Do not use equipment that damages the work, adjacent property, or public roads. When the contract specifies that the contractor use certain methods and equipment, use alternatives only after providing the engineer with a written request and obtaining the engineer's approval. If the

engineer approves the request to use alternative methods, the contractor still retains the responsibility to produce work in accordance with the contract. If, after trial use of the alternate methods and equipment, the engineer determines that the work does not meet the contract requirements, complete the remaining construction with the originally specified methods and equipment.

108.7 Extensions of Contract Time.

A. General.

1. Prosecute the work continuously and effectively, with the least possible delay so as to complete all the work within the contract time.
2. Upon encountering an excusable delay that meets the criteria specified in Sections 108.7.B, Excusable, Non-Compensable Delays, or 108.7.C, Excusable, Compensable Delays, submit a written request to the engineer for a contract time extension in accordance with Section 104.3, Notification of Contract Changes.
3. Failure to provide timely notice of a delay, in accordance with Section 104.3, Notification of Contract Changes, constitutes a waiver of the right to a time extension for the delay.
4. The Department will only extend the contract time if the contractor experiences an excusable delay to work on the critical path shown on the approved progress schedule that delays the scheduled substantial completion date based on the contract time.
5. The Department will use the same criteria to extend the contract time for a milestone date as it uses to determine an extension of contract time for substantial completion.
6. The engineer will evaluate delays and determine the time extension due based on the following:
   a. The progress schedules submitted to, and approved by, the Department. The engineer will not use schedules that were not submitted and approved by the Department or schedules the contractor created after the delay occurred.
   b. Failure to submit and receive approval of a progress schedule or failure to maintain the progress schedule in accordance with the requirements specified in Section 108.4, Progress Schedule, constitutes a waiver of entitlement to a time extension.
   c. The Department will only consider granting time extensions for delays to the critical path not caused by the contractor.
   d. The progress schedule relevant to the determination of a time extension is the progress schedule submitted to and approved by the Engineer that was in force when the delay was experienced. For example, if the Department determines that extra work is required and the change order for this work is dated June 2, then the contractor would use the last progress schedule submitted and approved by the Department prior to June 2 to show entitlement to a time extension.
   e. When submitting a request for a time extension, comply with the following requirements:
      i. Use time impact analysis (TIA) to identify and measure critical delays that have not yet occurred. Do not use this method to evaluate delays that have already occurred. In general terms, perform a TIA as follows:

      (1) Develop a “mini” schedule for the changed work. This schedule is known as a fragnet;

(2) identify the current accepted schedule and record the scheduled completion date on that schedule;

(3) insert the fragnet into the current schedule by properly linking the fragnet with the existing activities in the current accepted schedule;

(4) recalculate the current schedule with the fragnet inserted and record this scheduled completion date;

(5) the difference in the calculated scheduled completion dates between the current schedule and the schedule calculated with a properly inserted and properly composed fragnet is the delay attributable to the changed work. The engineer will base the time extension due, if any, on this delay.

ii. Use a contemporaneous analysis when evaluating delays that have already occurred. In general terms, perform a contemporaneous analysis as follows:

(1) Identify the most recent accepted schedule with a data date before the start of the delay being evaluated;

(2) identify each accepted schedule in effect during the delay and the schedule with a data date that immediately follows the conclusion of the delay;

(3) identify the critical path each day from immediately before the start of the delay to the schedule immediately following the delay;

(4) determine whether the delay falls on the critical path;

(5) if the delay does not fall on the critical path, then no project delay occurred and no time extension is due;

(6) if the delay falls on the critical path, then determine the number of days the critical path is delayed. The engineer will base the time extension due, if any, on this delay.

7. The engineer will review a time extension request and determine if a time extension is due.

8. The engineer will measure contract time extensions using working days for working day contracts and calendar days for calendar day contracts.

9. If approved, the engineer will prepare a change order to increase or decrease the contract time.

B. Excusable, Non-Compensable Delays.

1. Excusable, non-compensable delays are delays that neither the contractor nor the Department could have foreseen. These delays are not the fault or responsibility of the contractor or the Department.

2. The Department will not compensate the contractor for the costs associated with an excusable, non-compensable delay.

3. Excusable, non-compensable delays include delays due to:

a. Unforeseen events such as hurricanes, fires, floods, tornadoes, lightning strikes, earthquakes, or epidemics.

b. Material delivery delays resulting from events or actions that the contractor, its subcontractors, and suppliers could not foresee or avoid, and were not responsible for.

c. Civil disturbances or terrorism.

d. Labor strikes not caused by improper acts or omissions of the contractor, subcontractor, or supplier that are beyond the contractor's, subcontractor's, and supplier's power to settle.

e. The added quantity of a major item of work where the added quantity exceeds 125 percent of the approximate quantity shown in the bid proposal.

f. Utilities, including delays caused by the utility's failure to timely perform its work or unanticipated conflicts between the utility's facilities and the work.

g. Railroads.

h. Acts of government or political subdivisions other than the Department.

j. All other delays not the contractor's or Department's fault or responsibility that could not have been reasonably foreseen by the contractor or the Department.

4. Weather delays are non-compensable. The engineer will determine contract time extensions due to weather in accordance with Section 108.7.F, Weather Delays.

C. Excusable, Compensable Delays.

1. Excusable, compensable delays are the Department's responsibility.

2. Excusable, compensable delays include:

a. Changed work as specified in Sections 104.2.C, Differing Site Conditions, and 104.2.E, Extra Work.

b. Changed work as specified in Section 104.2.B, Significant Changes in the Character of Work, except delays due to significant changes caused by increases in quantity, which are non-compensable.

c. Delays due to an engineer-ordered suspension in accordance with Section 104.2.D, Suspensions of Work Ordered by the Engineer.

D. Non-Excusable Delays.

1. Non-excusable delays are the contractor 's responsibility. Non-excusable delays are not compensable.

2. Non-excusable delays include:

a. Insolvency or mismanagement of the contractor, a subcontractor, or a supplier.

b. Slow material delivery when the material was available in warehouse stock or when delivery was delayed for reasons of late ordering, or financial considerations.

c. The contractor's failure to provide sufficient forces and equipment to maintain progress.

d. Plant and equipment failure, failure to provide and maintain equipment in good mechanical condition, or failure to provide for immediate emergency repairs.

e. Conditions on the project the contractor could have foreseen or anticipated, such as traffic.

E. Concurrent Delays

1. Concurrent delays are independent critical delays that occur on the same dates. When a non-excusable delay is concurrent with an excusable delay, there is no entitlement to a contract time extension for the time the non-excusable delay is concurrent with the excusable delay. When an excusable, non-compensable delay is concurrent with a compensable delay, there is entitlement

to a contract time extension, but there is no entitlement to compensation for the period the non-compensable delay is concurrent with the compensable delay.

F. Weather Delays

1. A weather day is defined as a day that the contractor was planning to work in accordance with the contractor's progress schedule but could not work because of weather or seasonal conditions that prevented critical path work from occurring for more than half of the working day.
2. Submit the dates and number of weather days in writing to the engineer weekly for the engineer's review. The engineer will respond either by accepting or rejecting the weather days alleged by the contractor. If the engineer rejects the alleged weather days, the engineer will provide a determination of weather days within 7 calendar days of receiving the list of claimed weather days. If there is disagreement with the Engineer's determination, submit a written justification within 7 calendar days of receiving the engineer's list of weather days. The engineer will review the written justification and will respond within 7 calendar days. If there is disagreement with the engineer's response, provide notice as required by Section 104.3, Notification of Contract Changes.
3. Failure to submit weather days at the end of a week will result in the engineer determining the dates and number of weather days. The engineer will provide the determination of weather days in response to a written request.
4. Provide for weather and seasonal conditions in the progress schedule in accordance with Section 108.4.A.2.j. Once the Notice to Proceed date has been established, utilize Table 108.7-1 to determine the total number of anticipated weather days for the project. The Department will extend contract time by 1-day for each weather day that exceeds the total number of anticipated weather days for the project.

Table 108.7-1. Anticipated Weather Days per Month

Month	Weather Days		Month	Weather Days
January	20		July	4
February	20		August	4
March	15		September	5
April	10		October	6
May	5		November	10
June	5		December	20

5. If a non-excusable delay extends the performance of the work beyond the contract time, the contractor is not entitled to time extensions for weather days or seasonal conditions encountered beyond the contract time, even if the number of weather days exceeds the total number of weather days anticipated for the project.

108.8 Failure to Complete on Time.

A. For each calendar day or working day that work remains uncompleted after the contract time has expired, pay the Department the sum specified in Section 108.9, Schedule of Liquidated Damages.

B. The sums specified in Section 108.9, Schedule of Liquidated Damages, are liquidated damages. Liquidated damages are not a penalty.

C. For contracts that specify contract time in calendar days or contracts that have a specified completion date, the Department will base the assessment of liquidated damages on the amounts listed under the "Calendar Day" columns of the charts provided in Section 108.9, Schedule of Liquidated Damages. The Department will include every calendar day in the computation of liquidated damages.

D. For contracts that specify the contract time in working days, the Department will base the assessment of liquidated damages on amounts listed under the "Working Day" column of the chart provided in Section 108.9, Schedule of Liquidated Damages. The Department will calculate liquidated damages by counting each working day after the contract time expires.

E. Assessment of liquidated damages begins automatically as soon as the contractor fails to complete the work within the contract time. No Department action is required to begin the assessment. Failure of the Department to assess liquidated damages does not constitute a waiver of the Department's entitlement to recover liquidated damages.

F. The Department may deduct the amount of liquidated damages due from the pay estimate.

G. If the pay estimate amount is less than the liquidated damages due, pay the outstanding balance of liquidated damages due within 30 calendar days.

H. Failure to pay an outstanding liquidated damage balance due within 30 calendar days may result in the Department removing the contractor from the list of qualified bidders until the outstanding balance due is paid in full. In the case of joint ventures, the Department may remove each entity that makes up a part of the joint venture from the list of qualified bidders.

I. In addition to the assessment of liquidated damages, the Department will not pay for maintenance of traffic (MOT) devices or measures used during days when the Department is assessing liquidated damages. Examples of these costs include MOT devices, flaggers, traffic officers, and any lump sum MOT pay items. The Department will not pay for field office costs or the cost of providing CPM schedule updates during the liquidated damage period.

J. The Department does not waive its rights under the contract by allowing the contractor or its surety to continue the work after expiration of the contract time.

K. Once the Department determines that the work is substantially complete, the Department will suspend time charges and the assessment of liquidated damages. Failure to complete all punch list work identified during the initial and primary inspections within the timeframes allotted, will result in the Department restarting liquidated damages in accordance with the chart specified in Section 108.9, Schedule of Liquidated Damages. The assessment of post-substantial-completion liquidated damages will continue until project completion.

108.9 Schedule of Liquidated Damages.

A. The specific rates for assessment of liquidated damages, which are based on an estimate of the additional costs the Department and the traveling public may incur, are as follows:

Table 108.9-1. Schedule of Liquidated Damages

Awarded Contract		Value Daily Charge	
For More Than	To and Including	Working Day	Calendar Day
$0	$100,000	$770.00	$550.00
$100,000	$500,000	$1,190.00	$850.00
$500,000	$1,000,000	$1,420.00	$1020.00
$1,000,000	$2,000,000	$2,210.00	$1,580.00
$2,000,000	$5,000,000	$2,520.00	$1,800.00
$5,000,000	$10,000,000	$2,680.00	$1,920.00
$10,000,000	$15,000,000	$3,100.00	$2,220.00
$15,000,000	$20,000,000	$4,670.00	$3,340.00
$20,000,000	$25,000,000	$6,040.00	$4,320.00
$25,000,000	$30,000,000	$7,750.00	$5,540.00
$30,000,000	$35,000,000	$9,730.00	$6,950.00
$35,000,000	$50,000,000	$12,600.00	$9,000.00

B. The Department may designate rates for assessment of liquidated damages for contracts with an awarded contract value exceeding $35,000,000 by Special Provision.

108.10 Default of the Contract.

A. The engineer may give written notice to the contractor and the surety declaring the contract in default under the following conditions:

1. Failure to begin work within the time specified in the notice to proceed.
2. Failure to perform the work with sufficient labor, equipment, and material resources to ensure prompt completion of the work in accordance with the approved schedule.
3. If the contractor's work is unacceptable or if the contractor refuses to remove materials or correct work the engineer determines is defective or otherwise unacceptable.
4. Ceasing work and failure to resume the work.
5. Insolvency, bankruptcy, files for bankruptcy or insolvency, or allowing any final judgment to stand unsatisfied for a period of 10 days.
6. Making an assignment for the benefit of creditors without the Department’s authorization.
7. Failure to carry on the work in a manner acceptable to the Department.

B. Failure by the contractor or surety to remedy the condition in the default notice within 10 days after receiving the notice, will result in the engineer declaring the contractor in default of the contract. This action will terminate the contractor's right to proceed with the work and will give full power and authority for the work to the Department without violating the contract. The Department will take ownership of the contractor’s materials at the site suitable for use. The Department may enter into an agreement with another contractor for completion of the contract or use other methods to complete the contract.

C. The Department will deduct from monies due the contractor for completed work all costs and charges the Department incurs as a result of the default, including the cost of completing the work

under contract or remedying defective or otherwise unacceptable work, and applicable liquidated damages or disincentives. If the cost to complete the project exceeds the sum payable under the contract, the Department will hold the contractor and the surety liable for the costs in excess of the contract price.

D. If the Department determines, after termination of the contractor's right to proceed, that the contractor was not in default, the Department will convert the termination for default to termination for convenience in accordance with Section 108.11, Termination of the Contract for Convenience. The Department will limit the damages the contractor may have entitlement for, resulting from an improper default termination, to amounts in accordance with Section 108.11, Termination of the Contract for Convenience.

108.11 Termination of the Contract for Convenience

A. The Department may, by written order, terminate the contract or any portion of the contract when termination is in the best interests of the Department. In the event that termination occurs, without fault and for reasons beyond the contractor’s control, the Department will pay for all completed work at the contract price as of the termination date. The Department will pay for partially completed work or costs related to eliminated work in accordance with Section 109.8, Pay Estimates and Retainage.

B. The Department may elect to pay for acceptable materials obtained for the work but not used as of the termination. The Department will pay the actual cost of materials delivered to a prescribed location or otherwise dispose of the materials as mutually agreed.

C. After receiving the termination notice, the contractor may submit a request for additional damages or costs not covered by these specifications, within 60 days of the termination date. The request may include the following cost items:

1. Idle equipment time.
2. Mobilization efforts.
3. Uncompensated bidding and project investigation costs.
4. Overhead expenses.
5. Subcontractor costs.
6. Idle labor costs if the Department suspends the work in advance of the termination date.
7. Guaranteed payments for private land use as part of the original contract.
8. Any other direct cost or direct damage resulting from the termination.

D. The Department will not consider loss of anticipated profits as part of a termination settlement.

E. Ensure the availability of cost records for the Department to determine the validity and amount of each item claimed.

F. Termination of the contract or portion of the contract does not relieve the contractor of its contractual responsibilities for the completed work or relieve the surety of its obligation for any just claim arising out of the work performed.

108.12 Termination of the Contractor's Responsibility.

Termination of the contractor's responsibility for the work occurs upon final acceptance in accordance with Section 105.16, Partial Acceptance; Project Acceptance; Final Acceptance; and Project Closeout, except to the extent provided in Section 107.13, Contractor’s Responsibility for the Work after Final Acceptance; No Waiver of Legal Rights.

SECTION 109 — MEASUREMENT AND PAYMENT

109.1 Measurement of Quantities.

A. Unless stated otherwise, weigh material measured by weight as follows:

1. Weigh each loaded truck or other approved hauling equipment and 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. A Department Materials & Research inspector will sign weight tickets showing a net weight of each material load originating from a bituminous production plant and delivered to the project.
2. Use a scale platform capable of holding all trucks and other hauling equipment. Ensure that the entire vehicle rests on the scale platform to weigh it as 1 unit.
3. The State Sealer of Weights and Measures will certify scales used to weigh loads for payment.
4. Materials measured by weight that are stockpiled after delivery and before being placed, will not be paid by ticket. The volume will be measured by template, calculated, and converted to the items Unit of Measure. Unless a project specific conversion factor is mutually agreed to by the Department and Contractor, the conversion factors listed at https://deldot.gov/Business/drc/index.shtml?dc=pavement govern.

B. The Department defines a station, when used as a definition or term of measurement, as 100 linear feet.

C. Unless otherwise specified, the engineer will make longitudinal measurements for area computations horizontally. The engineer will make no deductions for fixtures having an area of 9 square feet or less such as manholes or utility poles. The engineer will make measurements for area computations using the neat dimensions shown on the plans.

D. The engineer will measure structures according to neat lines shown in the contract.

E. The engineer will take linear foot measurements for items such as pipes, culverts, guardrails, and underdrains parallel to the base or foundation the structures rest on.

F. The word "ton" for this specification means the United States unit of weight consisting of 2,000-pounds. Weigh material on scales approved by the State sealer of weights and measures. For materials shipped by rail, the engineer will accept the car weight information provided by the railroad. The engineer will not accept car weights for material that will pass through mixing plants. Ensure that each truck bears a plainly legible identification mark.

G. When requested by the contractor and approved by the engineer in writing, the contractor may weigh material specified for measurement by the cubic yard in the contract. The engineer will convert the weights to volumes for payment purposes. The engineer will determine the factors for converting weight measurement to volume measurement. The engineer and the contractor must mutually agree to conversions before using them. If the engineer and the contractor cannot agree on the conversion factors, the engineer will measure the material by volume in place.

H. The engineer will measure bituminous materials by the gallon.

I. The engineer will measure volumes at 60 degrees F or the engineer will correct the volume to 60 degrees F using ASTM D4311 for asphalt or ASTM D633 for tars.

J. When the contractor ships bituminous materials by truck or transport, the engineer may use net certified weights or volume, subject to correction for loss or foaming, for computing quantities.

K. The engineer will measure cement by the pound.

L. The engineer will measure timber by the actual MFBM incorporated into a structure.

M. The engineer will not measure lump sum items of work.

1. When a complete structure or structural unit is specified as the unit of measurement, the lump sum for the structure will include all necessary fittings and accessories.

2. The bid proposal may contain breakout sheets for lump sum items. Fill in a unit price for each line item on the breakout sheet. The Department will consider the lump sum bid for the respective pay items as the sum of the price items listed on the breakout sheet. Breakout sheets must be submitted with the bid documents or within 7 calendar days following the bid due date by the lowest apparent bidder.

N. When the contract specifies standard manufactured items identified by unit weight or section dimensions, the Department will consider this identification as nominal weights or dimensions. Unless more stringently controlled by tolerances specified elsewhere in the contract, the Department will accept manufacturing tolerances established by the industries involved.

109.2 Scope of Payment for Unit Prices; Payment of Subcontractors.

A. Receive and accept compensation provided in the contract as full payment for providing all materials and for performing work under the contract and for accepting all risk, loss, damage, and expense of any kind arising out of the nature or performance of the work, subject to the provisions of Section 107.13, Contractor's Responsibility for the Work after Final Acceptance; No Waiver of Legal Rights.

B. If the basis of payment clause, for an item relating to a unit price in the contract, states that the unit price is compensation for certain work or materials used to complete the work for that pay item, the Department will not measure or pay this same work or material under any other pay item appearing in the contract.

C. When requirements, responsibilities, and providing materials (collectively called "requirements" in this section) are outlined in the details, notes on the plans, 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.

D. Within 30 days of receipt of payment from the Department, submit a form provided by the Department stating that all subcontractors that provided labor or material at that stage of the project are paid in full except for 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.

109.3 Compensation for Altered Quantities.

A. When the accepted quantities of work vary from the quantities in the bid proposal, the contractor shall accept payment at the original contract unit prices for the accepted quantities of work performed. The Department will make no allowance for any increased costs, except as provided in

Sections 104.2, Contract Changes, and 108.11, Termination of the Contract for Convenience, or in any escalation clauses in accordance with the contract.

109.4 Compensation for Changes.

A. General

1. If the Department changes the contract, as provided in Section 104.2, Contract Changes, and the contractor provides timely notice in accordance with Section 104.3, Notification of Contract Changes, the engineer will determine the pricing method for the change following the sequence specified below in Sections 109.4.B through D.
2. Compensation for a change in accordance with Section 109.4, Compensation for Changes, constitutes full and complete compensation for performing the change.
3. The Department reserves the right to provide the materials for performing the changed work. The contractor is not entitled to payment for the cost of these materials or mark ups on the value of these materials.
4. If the change includes a time extension for compensable delays as provided by Section 108.7, Extensions of Contract Time, the Department will compensate the contractor for the costs associated with the time extension in accordance with Section 109.6, Compensation for Delay.
5. The Department will not pay for non-allowable charges specified in Section 109.5, Non-Allowable Charges, or duplicate payments that may result from the application of Section 109.6, Compensation for Delay, or any other provisions of the contract.

B. Unit Prices

Before proceeding to another pricing method, the engineer will attempt to price and pay for the change using unit prices in the contractor's proposal. The Department will pay for the change using unit prices when the change incorporates work that does not differ significantly from the work in the original bid.

C. Negotiated Prices

1. If the engineer and the contractor cannot agree on compensation for the change in accordance with Section 109.4.B, Unit Prices, the engineer and the contractor will attempt to negotiate unit or lump sum prices for the changed work using 1 or more of the following methods:
   a. Unit bid prices for similar pay items adjusted for increased or decreased costs.
   b. Historical unit bid prices for similar work and quantities.
   c. Unit prices determined by the Department.
   d. Cost analysis of labor, material, equipment, and mark ups as allowed in Section 109.4.D, Force Account.
2. Negotiated mark-ups for subcontractor work may not exceed that provided for in Section 109.4.D.14, Subcontracting.
3. Within 7 calendar days of the Department's request, submit a written proposal that includes pricing, cost justification, and a schedule for performing the changed work.
4. The Department will respond within 7 calendar days after receiving the contractor's proposal.

5. The Department and the contractor can mutually agree in writing to extend the 7-day time limits.

D. Force Account.

1. If the engineer and contractor are unable to agree to a price for a change in accordance with Sections 109.4.B, Unit Prices, or C, Negotiated Prices, the engineer may direct the contractor to perform all or part of the change using the force account pricing method. Obtain the engineer's written approval before proceeding with force account work.
2. When the engineer directs the contractor to perform the change using the force account pricing method, the Department will pay the contractor as specified in Sections 109.4.D.5. through 14.
3. Prior to starting work using the force account pricing method, the engineer will meet with the contractor to determine and agree on the labor, equipment, and materials needed to perform the change.
4. The engineer will make the final determination concerning what labor, equipment, and materials are needed to perform the change.
5. Follow the engineer's direction when performing the change.
6. The Department will not pay for the change in excess of the agreed amount using the force account pricing method if the engineer was not given an opportunity to review and approve the labor, equipment, and materials proposed by the contractor to perform the change and if the contractor did not follow the engineer's direction when performing the change.
7. Labor.
   a. The Department will compensate the contractor for labor at the actual rate of wage paid and shown on the certified payroll for every hour that the labor and working supervision worked exclusively on the changed work.
   b. The Department will pay for a foreman in charge of the changed work as direct labor and not in the overhead markup.
   c. The Department considers the cost of home office personnel, project executives, project managers, superintendents, general foreman, clerical personnel, assistants, and all other management and supervisory personnel as compensated by the mark ups allowed by Section 109.4.D.12, Overhead.
   d. Unless already included in the wage rates paid, the Department will also pay the actual labor-related costs of health and welfare benefits, pension funds, or other benefits, provided those payments are required by a collective bargaining agreement or other employment contract generally applicable to the classes of labor employed to perform the change.
8. Bond, Insurance, and Tax
   a. For bond premiums; property damage, liability, and workers compensation insurance premiums; unemployment insurance contributions; and social security taxes, the Department will compensate the contractor for the actual incremental cost necessarily and directly resulting from the performance of the change.
   b. Provide documentation, satisfactory to the Department, of the rate or rates paid for bonds, insurance, and taxes.

9. Materials.
   a. The Department will compensate the contractor for the cost of materials the contractor provided and used for the changed work.
   b. The material purchaser is the entity that purchased the material to perform the change. For example, if the change requires fabrication of structural steel, the steel fabricator that purchased the steel to fabricate the structural steel for the change is the material purchaser, not the contractor.
   c. The cost of contractor-furnished materials is the cost to the purchaser, together with transportation charges paid by the purchaser, except as the following apply:
      i. If a cash or trade discount by the actual supplier of the material is offered or available to the purchaser, credit that amount to the Department even if the purchaser did not take the discount.
      ii. For materials obtained from a supplier or source owned wholly or in part by the purchaser, the Department will pay the lowest of the following:
      (1) The price of similar materials previously purchased from a supplier.
      (2) The price of materials used by the purchaser on other Department projects.
      iii. The Department will pay the current wholesale price for materials if it is lower than the contractor's purchase price from its wholly or partially owned supplier.
   d. If the purchaser procures materials by methods other than a direct purchase and direct billing from the supplier, the engineer will pay the price paid to the supplier, plus the costs incurred in the handling the materials.
   e. If the contractor uses materials to complete the change that were taken from the contractor's stock, submit an affidavit certifying that the materials came from the contractor's stock, the quantity was used in the changed work, and the price and transportation costs represent the contractor's actual costs.
   f. If the engineer determines that the cost of materials for the changed work is excessive or the contractor fails to provide substantiation for material costs from the supplier, the Department will pay the lowest current wholesale price for the materials. The Department will pay for the required quantities delivered to the project site, less available cash or trade discounts offered by the actual supplier of the material.
10. Equipment.
   a. General.
      i. The Department will pay for each hour that the contractor uses an approved piece of equipment to perform the changed work.
      ii. Use equipment that the engineer agrees is in good operating condition.
      iii. Describe the equipment used in detail to document it for payment.
      iv. Select equipment of suitable size and suitable capacity for the changed work.
      v. The engineer will determine the suitability of the equipment.

vi. In the event the contractor elects to use equipment of a higher rental or hourly ownership cost than is suitable for performing the work associated with the change, the Department will pay the rate applicable to the suitable equipment.

vii. If there is a differential in the rate of pay of the operator of oversize or higher-rate equipment, the Department will pay the rate of an operator of the suitable equipment.

viii. The Department will not pay for the use of small tools. Small tools are defined as tools or equipment with a daily ownership and operating cost or daily rental rate and operating cost of less than $5.00. The Department will not pay for owned equipment not listed in the Rental Rate Blue Book (Blue Book) published by EquipmentWatch that cost less than $1,500 when new.

ix. The Department will pay for subcontractor-owned equipment as "Owned Equipment," as set forth below. The Department will pay for leased or rented equipment or equipment hired from a subcontractor as "Leased, Rented, or Hired Equipment," as set forth below.

x. The Department will not pay standby time for equipment that operated for more than 8 hours in a day or 40-hours in a week.

xi. The Department will pay standby time for equipment that operated less than 8-hours in a day or less than 40-hours in a week. The Department will base standby time on the difference between the operating time on a normal working day and 8 hours per day or the difference between the operating time in a normal work week and 40 hours per week.

xii. The Department will not pay for the time equipment is idle on a day that is not a normal working day.

b. Owned Equipment.

i. The Department will compensate the contractor for contractor-owned equipment at a rate determined from the Blue Book.

ii. Owned equipment is equipment and plant owned directly by the contractor or by entities that are divisions, affiliates, subsidiaries, or in any other way related to the contractor or its parent company.

iii. Use the Blue Book in the following manner:

(1) Determine the hourly rate by dividing the monthly rate by 176. Do not use the weekly, hourly, or daily rates.

(2) The Department will pay for the number of hours that the equipment or plant is used to perform the changed work.

(3) The Department will not pay for more than 176 hours per calendar month.

(4) Use the current edition of the Blue Book to establish the rates. The applicable current edition is the one that is current as of the first day of work performed on the change. That rate applies throughout the time it takes to perform the changed work.

(5) Make the area adjustment.

(6) Make the equipment life adjustment in accordance with the Blue Book rate adjustment tables.

(7) Charge the same rate for equipment used on overtime as charged for regular hours.

(8) Use the Blue Book operating rate for each hour the equipment or plant was in operation for the change. The Blue Book operating rate does not apply to idle time regardless of the cause.

(9) The Department will not compensate the contractor for equipment idle time unless the equipment was held on the project site at the engineer's written request.

(10) The Department compensates for idle time at 1/2 the rate established in (1) through (6) above.

(11) Compensation for idle time will not exceed 8-hours in a day and will not exceed 40-hours in a week.

(12) 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, incidentals, and all other costs.

(13) Do not include operator costs in the hourly equipment or plant rate.

(14) If the Blue Book does not have a rate for a piece of equipment, the engineer will establish a rate determined by audit in accordance with Section 107.15, Audits.

iv. If owned equipment required for the changed work is not available at the project site, the Department will pay the move-in cost of transporting the equipment to the project site and the move-out cost of moving the equipment off the site in accordance with the following:

(1) Obtain the engineer's approval of the equipment location before transporting the equipment to the project site.

(2) If the contractor chooses to keep the equipment at the project site to perform work other than the work associated with the change, the Department will not pay for the move-out costs.

(3) If the contractor chooses to return the equipment to a location other than the original location, the Department will pay a move-out cost that does not exceed the move-in cost.

(4) Calculate the equipment transportation cost to and from the project site using the hourly rates for labor and equipment determined in accordance with the labor and equipment provisions of this specification. The Department will not pay moving costs that exceed the costs of moving the equipment using an independent hauler instead of the contractor's own forces.

(5) If the contractor uses an independent hauler to transport contractor-owned equipment, the Department will pay the invoice price paid to the hauler and 50 percent of the hourly ownership costs as determined above in accordance with the Blue Book.

(6) Transportation costs include loading and unloading.

c. Rented Equipment

i. If the contractor does not own the required equipment, inform the engineer of the need to rent the equipment and of the rental rate before mobilizing the equipment to the site and using it to perform the changed work.

ii. The Department will compensate the contractor for the rented equipment by paying the rental rate for the time it is used to perform the changed work.

iii. The Department will compensate the contractor for the cost of moving the rented equipment on and off the project if the moves are necessary only because of the changed work.

iv. For idle rental equipment that must remain on the site because of the engineer's written directive, the Department will pay for the rented equipment at the rental rate established above for rented equipment, not to exceed 8-hours in a day or 40-hours in a week.

v. The Department will not pay for rented equipment costs in excess of the actual cost paid for the rental.

vi. Provide a copy of the paid receipt or canceled check for the rental expense incurred.

vii. The Department will pay the operating costs of rented equipment used for the changed work based on the Blue Book operating costs for the same piece of equipment.

11. Daily Records

a. Use the Department's Daily Force Account form to document daily the labor, equipment, and materials used to perform the changed work.

b. Complete the Daily Force Account form to provide a clear distinction between the changed work and all other work.

c. Provide all information required by the Daily Force Account form, including:

i. The name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman.

ii. The designation, number, date, daily hours, total hours, rental rate, including a copy of the Blue Book pages used, and extension for each piece of equipment and associated attachments.

iii. The quantities of materials, prices, and extensions. Substantiate material costs with copies of vendor's invoices. Submit vendor invoices with the Daily Force Account forms or, if not available that day, submit the invoices with subsequent Daily Force Account forms. Failure to submit vendor's invoices within 60 calendar days after the date of material delivery, or within 15 calendar days after completing the changed work, whichever occurs first, will result in the engineer establishing the material costs. The engineer will use the lowest current wholesale prices for similar materials, available in the quantities used for the changed work, delivered to the project, less any available discounts.

iv. The cost of material transportation.

v. The cost of insurance premiums for property damage, liability, and workers compensation insurances; unemployment insurance contributions; bonds; and social security taxes.

d. At the end of each workday:

i. The engineer will compare the records the engineer kept with the completed Daily Force Account form the contractor submitted.

ii. The engineer and the contractor will review and attempt to reconcile differences with the Daily Force Account form record.

iii. After the engineer and the contractor agree on the content of the Daily Force Account form submitted at the end of the workday, both parties will sign the form.

e. The Department will use the completed and signed Daily Force Account form as the basis for determining the amount due the contractor. However, the Department may subsequently increase or decrease the compensation paid based on an audit of the contractor's records. Allow the Department access to force account compensation cost records for inspection or audit in accordance with Section 107.15, Audits.

f. If the contractor fails to submit the Daily Force Account form daily or refuses to sign the Daily Force Account form, the Department will use the engineer's records for payment.

12. Overhead.

a. The Department defines overhead to include the following:

i. Home office expenses, including the salaries and expenses of executive officers, area or regional managers, managers, supervisors, and engineering, estimating, administrative, and clerical personnel. Home office expenses are expenses incurred by the contractor not charged directly to any one project. These expenses are identified as general and administrative expenses.

ii. Field office expenses, including project executives, project managers, general superintendents, superintendents, assistants, and non-working foremen. Field office expenses are expenses incurred by the contractor on a specific project but not charged to a particular item of work. For example, the cost of a job site trailer is a field office expense, but the cost of a cubic yard of concrete used in a bridge footing is not because there is an item, or items, for the bridge work.

iii. Cost of small tools, such as shovels, picks, axes, saws, bars, sledges, lanterns, jacks, cables, pails, wrenches, and the cost of other miscellaneous supplies and services.

iv. Computers, copiers, and other office equipment.

b. The Department will compensate the contractor for overhead at 10 percent of the following:

i. Bare material costs calculated in accordance with Item 9 above, not including freight on board (FOB) costs.

ii. Direct labor costs calculated in accordance with Item 7 above.

iii. Equipment costs calculated in accordance with Item 10 above.

iv. The Department may pay for extraordinary overhead expenses, such as hiring of additional supervisory personnel or purchase of a specialty small tool the contractor has to purchase specifically for the changed work. The Department will only pay for extraordinary overhead expenses if the engineer agreed to the costs before the contractor incurred the costs.

13. Profit.

a. The Department will compensate the contractor for profit at five percent of the following:

i. Bare material costs calculated in accordance with Item 9 above, not including FOB.

ii. Direct labor costs calculated in accordance with Item 7 above.

14. Subcontracting.

a. For administration costs in connection with subcontract work, the Department will pay an amount equal to 10 percent for subcontractor work up to $100,000 and five percent on work exceeding $100,000 determined in accordance with Items 7 through 13 above.

E. Acceleration.

1. The engineer may direct the contractor, in writing, to accelerate the work.
2. If the engineer directs the contractor to complete the work early or directs the contractor to accelerate to mitigate excusable delays and accelerating the work will result in added costs, provide notice of a change in accordance with Section 104.3, Notification of Contract Changes.
3. The contractor is not entitled to compensation for the acceleration unless the contractor has:
   a. Provided notice in accordance with Section 104.3, Notification of Contract Changes.
   b. The engineer directed the acceleration in writing.
   c. The engineer directed the contractor to complete the work in less than the contract time or to mitigate an excusable delay instead of granting a time extension.
4. The engineer will compensate the contractor for directed acceleration in accordance with Section 109.4, Compensation for Changes.
5. If the Department uses the force account method to compensate the contractor for acceleration, the Department will modify Section 109.4.D, Force Account, as follows:
   a. If acceleration requires working overtime or additional shifts, the Department will pay for the overtime shift premium and the health and welfare benefits, pension fund, or other benefits costs directly related to the overtime shift premium. The Department will pay for benefits required by collective bargaining agreements or other employment contracts applicable to the classes of labor used for the changed work. The Department will also pay for workers compensation insurance premiums, unemployment insurance contributions, and social security taxes.
   b. The Department will not pay for additional supervision to oversee work during overtime hours or during additional shifts. Compensation for this supervision is included in the allowable labor overhead markup.
   c. The Department will pay for equipment used during overtime hours or on extended shifts at the same rate used for regular time or normal shifts.
   d. If the engineer requests the contractor to expedite material deliveries to accelerate the work, the Department will pay the expediting costs.

F. Payments

Compensation for changed work paid, in accordance with Section 109.4, Compensation for Changes, is full and complete compensation for the changed work, except to the extent that the contractor is also entitled to compensation for an excusable and compensable time extension due to the changed work. The Department will determine the contractor's entitlement to a compensable time extension in accordance with Section 108.7, Extensions of Contract Time. The Department will determine compensation for the time extension in accordance with Section 109.6, Compensation for Delay.

109.5 Non-Allowable Charges.

A. The Department will not pay for the following:

1. Extended, under-absorbed, or unabsorbed home office overhead or profit in excess of that specified in Sections 109.4.D.12, overhead, and 109.4.D.13,profit, and 109.4.D.14, subcontracting, and 109.6.B.5, percentage markups.
2. Consequential damages, including loss of bonding capacity, loss of bidding opportunities, or insolvency.
3. Inefficiency or loss of productivity.
4. Indirect costs.
5. Attorney's fees or other costs of dispute resolution, arbitration, or litigation.
6. Claim preparation expenses.
7. Interest.
8. The Department will not pay for profit on costs of suspensions or delays as specified in Section 104.2, Contract Changes. Remove profit from the mark-ups allowed in Section 109.4.D.13, Profit.
9. All other costs not specifically allowed by Section 109.4, Compensation for Changes.

109.6 Compensation for Delay.

A. General.

1. For compensable delays identified in Section 108.7, Extensions for Contract Time, the Department will pay the costs specified in Section 109.6.B, Allowable Delay Costs.
2. The Department will not pay for non-allowable charges specified in Section 109.5, Non-Allowable Charges, or duplicate payments made under Section 109.4, Compensation for Changes, or other payment provisions in the contract.
3. The Department will pay for delay costs if the contractor submits an itemized statement of those costs using the headings and subheadings of Section 109.6.B, Allowable Delay Costs.

B. Allowable Delay Costs.

1. Extended Field Office Expenses.
   a. The Department will pay for extended field office expenses resulting from a delay, including general field supervision, field office facilities and supplies, and for maintenance of field operations. General field supervision labor costs include costs such as project executives, project managers, project engineers, superintendents, assistants, security, clerical, and other field support staff not attributed to specific pay items. Calculate labor costs in accordance with Section 109.4.D.7, Labor.
   b. To calculate the daily wage rate paid for salaried personnel, divide the weekly salary by 7-days.
   c. Field office facility and supply costs include items such as field office trailers, tool trailers, office equipment rental, temporary toilets, and other field office support costs. Calculate the costs on a calendar-day basis using actual costs incurred due to the delay.
   d. Maintenance of field operations costs include items such as telephone, electric, water, and other similar expenses. Calculate the costs on a calendar-day basis using actual costs incurred due to the delay.

2. Idle Labor and Labor Escalation.
   a. Calculate labor costs during delays as specified in Section 109.4.D.7, Labor, for all non-salaried personnel remaining on the project as required under collective bargaining agreements or for other engineer-approved reasons.
   b. Calculate labor cost escalation by comparing the labor costs incurred to the labor cost the contractor would have incurred had there been no delay. Calculate labor costs in accordance with Section 109.4.D.7, Labor.
3. Bond, Insurance, and Taxes.
   a. Calculate bond, insurance, and tax costs in accordance with Section 109.4.D.8, Bond, Insurance and Tax.
4. Idle Equipment or Equipment Mobilization and Demobilization.
   a. The Department will compensate the contractor for equipment, other than small tools, that must remain on the project as a result of the delay.
   b. Calculated the costs of idle equipment in accordance with Section 109.4.D.10, Equipment.
   c. The Department will pay the transportation costs to remove and return equipment not required on the project during the compensable delay. Calculate the costs of equipment transportation in accordance with Section 109.4.D.10, Equipment.
   d. Material Escalation or Material Storage.
      i. The Department will pay for increased material costs or material storage costs due to a compensable delay. Obtain the engineer's written approval before storing material due to a delay.
      ii. The Department will pay for actual storage costs due to the delay.
      iii. The Department will pay for material cost escalation by comparing the costs incurred to cost the contractor would have incurred had there been no delay. Calculate material costs in accordance with Section 109.4.D.9.
5. Percentage Markups.
   a. An additional 10 percent markup on: field office expenses; idle labor and labor escalation; bond, insurance, and taxes; and idle equipment or equipment mobilization and demobilization costs is allowed to cover home office overhead, profit, and any other costs attributed to the delay for which no specific allowance is provided. This is the only markup allowed for a compensable delay. Markups from Sections 109.4.D.12, overhead, and 109.4.D.13, profit, and 109.4.D.14, subcontracting do not apply.
6. Records.
   a. The Department will not compensate the contractor for delays until the contractor provides the engineer with duplicate itemized cost statements as specified in Sections 109.6.B, allowable delay costs, B.1, B.2, B.3, B.4, and B.5 above in accordance with Section 109.4.D.11, daily records.

109.7 Basis of Payment for Fixed Quantity Items.

A. When indicated by the contract, the Department will pay certain items on the basis of an estimated fixed quantity. 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.

B. When the contract indicates estimated fixed quantities, the only quantities the Department will pay for are the estimated quantities shown in the proposal at the unit prices, except in certain situations described below in Sections 109.7.C.1, C.2, and C.3.

C. When bidding, check the estimates provided in the contract and appraise the actual amount of labor, equipment, or material required to complete the work in accordance with the contract. The Department will make no allowance or consider claims for quantities used in completing the work in excess of those given in the proposal unless:

   1. The contractor encounters a differing site condition that causes the estimated fixed quantity to change.

   2. The engineer adds or deletes work to the contract that increases or decreases a fixed quantity item.

   3. 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.

D. When differing site conditions cause an estimated fixed quantity to change, the engineer will adjust the payment in accordance with Section 104.2.C, Differing Site Conditions.

E. In cases where the contractor contests a fixed quantity, provide measurements and computations to support the claim of a difference in the quantity. If the engineer verifies and approves the difference and the error in the estimated fixed quantity exceeds 25 percent, the Department will compensate the contractor at the unit price for the actual quantity of work performed under the item.

109.8 Pay Estimates and Retainage.

The engineer will create a monthly written estimate of the work performed that will include the value of completed work to the estimate date. The Department may retain up to the value of the work performed as security for contract fulfillment. The Department will allow the contractor to substitute securities 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. The Department will make no estimates or payments when the work is not proceeding in accordance with the provisions of the contract. The engineer may make estimates more frequently than 1 in each month and may make payments more frequently to the contractor.

109.9 Payment for Stored Material.

A. The engineer may include an allowance in the pay estimate for the value of tested and accepted non-perishable materials or for materials the engineer is confident are safe from contamination after purchase. These are materials the contractor produced or provided in condition-ready use as a permanent part of work not yet completed. In order to receive payment for these materials, meet the following terms and conditions:

   1. Request.

a. Provide a written request for payment of stored materials accompanied by an itemized inventory statement, written surety consent, and an invoice or purchase order on the supplier's letterhead documenting the material cost. The Department will make no payment allowance for amounts less than $25,000.00 for each material of a qualifying pay item.

2. Materials.

a. The Department will make a payment allowance of 100 percent of the contractor's material costs, not to exceed 90 percent of the pay item price, when the contractor delivers and stockpiles or stores material in accordance with the contract requirements for the project. The Department will not pay for quantities of material in excess of the estimated quantities listed in the contract.

b. The department will pay for tested and accepted material only.

3. Excluded Materials.

a. The Department will make no payment for fuels, form lumber, falsework, temporary structures, or other materials used to perform the work but will not become a permanent part of the finished construction.

b. The Department will make no payment allowance for stockpiled or stored cement, aggregate, sand, seed, plants, fertilizer, or perishable material or for material subject to contamination after purchase and before use in the work. The Department will not make a payment allowance for materials that exceed the manufacture's expiration dates or materials that have an environmental or safety restriction.

4. Storage.

a. Store materials in a manner approved by the engineer in areas where damage is unlikely. Use stored materials only for the project and not for other projects.

b. When it is not practical to store materials within the project limits, the engineer may approve material storage on private property or, for structural members, in the manufacturer's or fabricator's yard. Include a release from the property owner or tenant stating that any fees in the lease agreements for removing the material from the property are the responsibility of the contractor and not the Department. Do not include these fees in any payment requests for material stored outside the project limits.

5. Materials Inventory.

a. Ensure that materials are available for the engineer, or the engineer's authorized representative, to inspect and inventory at the storage site at any time.

6. Materials Measurement and Payment.

a. Provide materials measured in units acceptable to the engineer that the engineer can easily inventory.

b. The engineer will include payment for materials in the progress estimate as a new and separate item that is subject to the retainage provisions in Section 109.9, Payment for Stored Material.

c. Submit proof of payment for materials to the engineer in the form of a paid invoice from the material supplier, before the engineer processes the next progress estimate. Failure to submit proof of payment before the engineer processes the progress payment will result in a

deduction of the applicable material payment in its entirety from progress payments until the engineer receives proof of payment.

d. As the contractor uses the materials that the Department paid for separately and as the Department pays for the work the contractor uses the material for under the applicable unit prices, the Department will deduct an equal percentage of the material payment the Department previously made from the progress estimates until the Department has deducted 100 percent of the total payment.

e. At the conclusion of the work that the contractor used the materials for, the Department will deduct the cost of materials remaining in storage that the Department paid for in accordance with Section 109.9.A.2, Materials, from the progress estimate.

109.10 Withholding of Money Due on an Estimate to Offset a Contractor's Liability.

A. The Department will deduct the cost of liquidated damages from the monthly and final estimates. Payment of any current or final estimate or of any retained percentage will not affect the contractor's obligation to repair or replace defective parts of the construction or the contractor's responsibility for damage due to such defects.

B. The Department has the right to retain an amount sufficient to completely indemnify the Department against any lien or claim the Department might become liable for and which is chargeable to the contractor, out of any payment then due or to become due. If there is a claim after the Department has made all contract payments, provide a refund to the Department for costs the Department paid to discharge liens that resulted from the contractor's neglect or default.

C. Upon substantial completion of the work, the engineer may release 60 percent of the retained amount. The Department will hold the balance of the retained amount until the contractor delivers all required reports to the Department and the Department authorizes final payment. The Department may retain temporarily or permanently a smaller amount and may pay the contractor temporarily or permanently the portion of the amount retained as the Department deems equitable.

D. Do not interpret any provision contained in these specifications as creating any debt, liability or obligation on the part of the State or the Department to any subcontractor, supplier, or materialman.

109.11 Final Payment and Time Limit to Challenge Quantities.

A. The engineer will make a final estimate of the work performed in accordance with Section 763, Initial Expense, De-Mobilization, after contract completion. The Department will pay the entire sum due after deducting from all previous payments all amounts to be kept and all amounts to be retained under the provisions of the contract. The Department will use the final estimate to reconcile errors in partial estimates and payments previously made. Provide notice to the engineer of alleged errors in the payment of contract quantities. Provide the notice within 120 calendar days of the date when the engineer finalizes the contract quantities. The engineer will notify the contractor after the engineer finishes finalizing the quantities. 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 prevents the engineer from performing audits of the engineer's records or the contractor's records and to adjust payment based on the audit results in accordance Section 107.15, Audits.

B. The contractor's acceptance 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.

109.12 Source of Supply and Carrier Rates on Construction Materials.

A. Bidders must fully inform themselves as to the source of material supply and in regard to the carrier rates and transportation facilities for these materials before submitting proposals.

B. The Department will not consider the contractor's inability to secure satisfactory materials from the source the contractor based its bid on, changes in carrier, or the alteration of transportation facilities for these materials during the life of the contract as cause for a claim for extra compensation.

109.13 Transportation Tax Exemption.

A. Ensure that base unit prices do not include transportation taxes the State is, by law, exempt from paying on materials entering into, and forming a part of, the project.

B. In order to obtain the transportation tax exemption on materials and to have the construction materials consigned to the State, in care of itself, provide the supplier with a statement certifying that the contractor is authorized to claim the exemption, identifying the contract the Department gave authorization in and instructing the supplier to make the shipment involved free of tax.

DIVISION 200 — EARTHWORK

SECTION 201 — CLEARING AND GRUBBING

201.1 Description.

This work consists of clearing and grubbing the project site in preparation for construction.

201.2 Materials.

Not applicable.

201.3 Construction.

201.3.1 General.

A. Clear and grub vegetation, trees, stumps, roots, and other debris.

B. Replace usable embankment and topsoil removed during clearing and grubbing.

C. Use a root rake to prevent wasting embankment and topsoil during the grubbing operation.

D. Clear the ground of all living and dead trees, stumps, brush, and other debris.

201.3.2 Trees and Roadside Amenities Designated to Remain.

A. Protect items designated to remain.

B. Place a temporary construction fence to protect trees designated to remain. Place the fence at the drip line of the trees.

C. Engage a certified tree surgeon to evaluate trees damaged by the clearing and grubbing operations. Repair or replace the trees as recommended by the tree surgeon.

D. Prune tree branches overhanging the roadbed to maintain a vertical clearance height of 20-feet above the roadway.

E. Prune trees or shrubs overhanging the pedestrian path to achieve a vertical clearance height of 10-feet above and 2-feet adjacent to the sidewalk, trail, or shared use path on either side.

F. Prune trees and shrubs overhanging the utility limits within the right of way and easement limits of construction. Remove obstructions at the edges of the utility limits and the easement limits from the ground up in a vertical plane until no trees or shrubs cross the utility and easement limit lines at any point.

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

201.3.3 Disposal.

Dispose of all waste materials in accordance with Section 106.8.

201.3.4 Preparation of Ground Surface.

A. Clear, grub, and excavate for installation of ditches and sediment controls before clearing and grubbing the remainder of the contract.

B. Complete all clearing and grubbing before excavating or grading.

C. Clearing and grubbing depths:

1. Remove root mat, including stumps, to the following minimum depths unless otherwise specified in the contract:
   a. Forested areas within tree lines shown in the contract: 2-feet
   b. Scrub wooded areas: 1-foot
   c. Field areas: vegetation only

D. If the contract requires cross sectioning, level and fill voids or cavities caused by the clearing and grubbing activities. Compact the existing material after clearing and grubbing before cross sectioning and placement of embankment lifts.

E. Based on soil conditions encountered after completion and acceptance of clearing and grubbing, the engineer may restrict earth-moving activities for a maximum of 14 calendar days to allow the ground to dry and solidify.

201.3.5 Clearing and Grubbing Limitations.

A. The engineer may limit clearing and grubbing to ensure compliance with the applicable erosion and sediment control regulations and specifications.

B. The maximum allowable exposed area of erodible soil is 20-acres.

201.4 Method of Measurement.

A. The Department will not measure clearing and grubbing.

201.5 Basis of Payment.

A. The Department will pay for clearing and grubbing as a lump sum item. Payment is full compensation for all work described in this section.

B. The Department will consider all costs associated with the engineer's direction to restrict earth-moving activities as incidental to the work.

ITEM	DESCRIPTION	UNIT
201000	CLEARING AND GRUBBING	LS

SECTION 202 — EXCAVATION AND EMBANKMENT

202.1 Description.

This work consists of excavation and embankment work.

202.2 Materials.

A.	Borrow	Section 209 and Section 1001
B.	Concrete	Section 1022
C.	Flowable Fill	Section 208 and Section 1047.1

202.3 Construction.

202.3.1 General.

A. This work consists of:

1. removing and finally disposing of all materials taken from within the limits of construction;
2. removing and finally disposing of Bituminous and PCC Pavement;
3. grading and compacting of embankments, roadways, and shoulders;
4. providing a uniform and smooth finish to excavation and embankment surfaces;
5. constructing, shaping, and sloping ditches, embankments, and cut slopes;
6. constructing and maintaining temporary edge berms, interceptor berms, and embankment slopes associated with erosion control methods in accordance with Division 900;
7. undercutting;
8. salvaging and stockpiling topsoil for re-use;
9. salvaging and stockpiling suitable borrow materials for re-use;
10. backfilling areas from which unsuitable materials have been removed; and
11. removing and disposing of all material not otherwise provided for, so that the project is completed in a neat and workmanlike manner.

B. This work does not consist of the removing and finally disposing of materials specified to be removed and disposed under other pay items.

202.3.2 Preparing for Earthwork Operations and Maintaining the Site during Earthwork Operations.

A. Clear, grub, and remove topsoil in accordance with Section 201 before beginning excavating, grading, and embankment work.

B. Perform survey layout in accordance with Section 105.10 before performing excavation and embankment work.

C. The engineer will cross section the existing ground after clearing and grubbing is complete but before earth moving operations begin.

D. Haul roads.

1. Construct haul roads as necessary to perform the excavation and embankment work.
2. Obtain approval before constructing haul roads outside of the LOC.
3. Maintain haul roads for the duration of the project.
4. Remove haul roads before project completion and restore the areas to existing conditions.
5. The Department will not allow construction of haul roads through wetland areas unless the contractor obtains the approval of the U.S. Army Corps of Engineers or both, as applicable.

F. Dust control.

Control dust by using water during earth-moving operations.

G. Grade to Drain.

1. Maintain the subgrade in such condition that it drains.
2. Provide and maintain temporary ditches from the subgrade to side ditches at intervals necessary to provide subgrade drainage.
3. Provide and maintain all facilities necessary for the complete drainage of the construction area.
4. Provide sediment and erosion control measures for all water drained or pumped from the subgrade in accordance with the contract.

H. Stability.

1. Replace embankment that, in the engineer's judgment, is damaged or displaced due to the following:
   a. Carelessness or negligence of the Contractor;
   b. rain events;
   c. shrinkage of embankment material; or
   d. other reasons not attributable to movement of the natural ground under the embankment.
2. Compact lifts in embankment areas, other than rock, in accordance with Section 202.3.8.D.
3. The Department will perform compaction and moisture tests once the contractor tests the stability of the lift in accordance with Section 202.3.8.F.

202.3.3 Excavation.

A. Excavate material in accordance with the contract or as directed by the engineer.

B. The engineer will not pay for materials excavated beyond the established limits.

C. All material meeting the requirements of Section 1001 is suitable material. All other material is unsuitable material.

D. Obtain the engineer's approval before removing material from the site.

E. Use suitable excavated material to construct embankments, shoulders, and slopes or as directed by the engineer.

1. Excess excavated suitable materials become the property of the contractor; remove such materials from the project as specified in Section 106.8.

2. Do not import borrow material without the approval of the engineer until all suitable excavated material has been used.

F. Dispose of unsuitable excavated material in accordance with Section 106.8.

1. The engineer may direct the contractor to embank unsuitable material.
2. Dispose of hazardous material found during excavation in accordance with Section 107.

G. Clean, clear of obstructions, and leave in a neat and trimmed condition:

1. All existing ditches and waterways and
2. all new or existing pipes, culverts, and drainage structures not designated for removal.

H. Stripping and Stockpiling Topsoil.

1. Remove topsoil from all cut sections and from fill sections where embankment heights are less than 5 feet measured vertically from the bottom of fill to subgrade.
2. Stockpile topsoil meeting the requirements of Section 908 that the contractor cannot immediately place. Stockpile in accordance with Section 908.3.A.
3. Stockpile sufficient topsoil to satisfy the topsoiling requirements of the contract.
4. Place remaining topsoil at the outer portions of embankment as shown in the contract.
5. Excess topsoil remains the property of the Department unless the Department grants the ownership of the excess topsoil to the contractor.
6. Load excess topsoil that is the property of the Department onto Department vehicles for removal.

I. If the Department grants the contractor ownership of the excess topsoil, remove in accordance with Section 106.8.

J. Stockpile suitable excavated material, meeting the requirements of Section 1001.

1. Stockpile material meeting borrow requirements that the contractor cannot immediately place in fill areas for later use. Stockpile in accordance with Section 908.3.
2. Manage stockpiled material, including mixing soils, or drying them, to meet the needs of the project.
3. Keep stockpiles generated from fill areas separate from stockpiles generated from cut areas.
4. Load, haul, place, and compact stockpiled material in fill areas or for the formation of embankments, shoulders, and slopes.
5. Place or stockpile excess materials generated from other pay items suitable for embankment purposes. This includes material generated from bituminous pavement removal, incidental removal, and any other construction materials suitable for use as fill material.
6. Separately place or stockpile excess material generated by others, including other contractors or utility companies and utility contractors performing work within the limits of construction.

K. When stockpiling material outside of the LOC, do so in accordance with the contract and provide an approved Erosion & Sediment Control plan.

L. Temporary stockpile stabilization material in accordance with Section 908.3.

202.3.4 Obstructions Encountered during Excavation.

A. Remove and dispose of pipes, underdrains, drainage inlets, and conduits encountered within the limits of the excavation unless otherwise noted in the contract.

B. Remove and dispose of all obstructions not covered under Section 201, Section 207, or Section 211 that are located below existing ground and within the excavation limits in accordance with Section 211.

C. Backfill voids created by removing obstructions, unless otherwise directed, use Borrow Type F material meeting the requirements of Section 1001, in accordance with Section 201.3.4.

D. Remove sections of pipes that are partially within the excavation limits under this section.

E. Unless otherwise designated to remain, either remove and dispose of existing pipes or submit requests to the engineer to abandon pipes in place. If the engineer approves abandoning the pipes in place, fill pipes with flowable fill and plug both ends with Class C concrete.

F. Salvage removed pipe if requested by the engineer. Salvaged pipe will remain the Department's property. Store salvaged pipe on or adjacent to the project for transport by the Department.

202.3.5 Preparation of Subgrade.

A. Maintain the subgrade in such condition that it drains. Provide and maintain temporary ditches from the subgrade to side ditches at intervals necessary to provide subgrade drainage. Provide and maintain all facilities necessary for the complete drainage of the construction area. Provide sediment and erosion control measures for all water drained or pumped from the subgrade in accordance with the contract.

B. Scarify the top 6 inches of subgrade and adjust moisture content to achieve the specified density and stability. 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. Do not allow vehicles to travel in a single track and form ruts in the subgrade.

C. Prior to placing subsequent lifts of material, proof roll the subgrade in the presence of and as directed by the engineer in accordance with Section 202.3.6.

D. The engineer will determine the maximum density for subgrade and embankment material in accordance with AASHTO T99 Method C Modified and in-place field density in accordance with AASHTO T310. Compact the subgrade to 95 percent or more of the maximum density.

E. Ensure the finished subgrade surface is uniform and 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 1/2-inch.

F. In cut sections, shape and compact the subgrade before placing subbase, base, or surfacing material. Remove boulders, large rocks, muck, vegetation, or other foreign materials from the subgrade unless directed by the engineer. Fill depressions that develop during rolling with suitable material and continue to roll the subgrade until no depressions develop.

G. Before placement of base material in fill sections, 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.

202.3.6 Proof Rolling.

A. Perform proof rolling as directed by the engineer with a fully loaded, 10-wheel dump truck or other equipment approved by the engineer.

B. The contractor may place a lift of earth or other material after the engineer accepts the proof roll.

C. The Department will not take compaction tests until the lift is deemed stable by the engineer. No soft, yielding, or spongy areas will be deemed stable.

D. Run the equipment longitudinally until the unrolled area between tire strips is less than 18-inches.

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

202.3.7 Undercut Excavation.

A. Preparation

1. When encountering unstable subgrade or foundation conditions, perform all normal construction preparation procedures to correct the unstable situation before undercutting. Normal construction preparation procedures include:
   a. The addition of moisture to obtain the maximum density in accordance with AASHTO T99. Compact the subgrade to 95 percent or more of the maximum density.
   b. Discing to aerate or mix the material to obtain the maximum density in accordance with AASHTO T99 and AASHTO T310. Compact the subgrade to 95 percent or more of the maximum density.
   c. Using properly sized equipment in such a way that the equipment does not cause rutting of the subgrade or foundations.
   d. Cutting channels, ditches, and grading to prevent excessive surface water from entering the subgrade or foundation materials
2. After performing normal construction preparation procedures, allow sufficient time to elapse to accurately judge the success of these procedures.
3. The contractor has the option of replacing the subgrade or foundation material as a means of correcting instability.
4. The engineer will interpret the terms “normal,” “sufficient,” and “reasonable.”
5. If the above procedures do not stabilize the subgrade, the engineer may direct the contractor to perform undercut excavation.

B. Undercut Excavation.

1. Undercut excavation consists of excavation below the limits provided by the contract for the purpose of correcting unstable subgrades and embankment foundations.
2. The correction of instability, as directed but 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.
3. When the engineer determines that undercutting is required, the engineer will direct the contractor to remove the material from within defined areas and depths. The engineer may

direct additional undercutting below the original defined depth. Dispose of excavated material in accordance with Section 106.8 unless otherwise directed by the engineer.

4. Use equipment that is capable of removing and replacing the material within the limits established by the engineer. Do not use equipment that will displace the underlying or adjacent material.
5. Upon acceptance of the undercut excavation, unless otherwise directed, use Borrow Type C in accordance with Section 1001 to backfill and compact the area in accordance with this section. Conduct undercut operations in a manner that allows the engineer time to take necessary measurements before placing backfill. The Department will not allow placement of backfill material in water unless approved by the engineer.
6. Rework areas that remain unstable after backfilling in accordance with this section. When rework becomes necessary, salvage and reuse as much of the previously placed backfill as possible. Correct unstable subgrade or embankment foundation that exists.

C. Performance Requirements.

Ensure that the correction of an unstable condition results in a firm, unyielding foundation.

202.3.8 Embankment Construction.

A. General.

1. Embankment construction includes preparing areas for embankment placement and placing, and compacting material that meets the requirements of Section 1001.
2. Use all suitable excavated material to construct embankments prior to importing borrow.
3. Obtain approval from the engineer to use imported borrow instead of material excavated on-site.

B. Equipment.

1. Provide sufficient equipment to grade, level, and compact after depositing embankment material. Cease placement of embankment material when the pace of grading and compacting the material cannot keep pace with the excavation or placement of the material.
2. Use approved rollers, compactors, or other suitable compaction equipment. Ensure all equipment is configured and operated to meet the requirements specified.

C. Preparation of Embankment Areas.

1. When placing embankment on hillsides or against existing embankment with slopes steeper than 6:1, build benches. Backfill the benched area continuously in loose lifts no deeper than 8 inches. 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 only with the new embankment material.
2. Where the height of the embankment at the subgrade level is 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 the subgrade material to the specified embankment density in accordance with AASHTO T99 and AASHTO T310. Compact the subgrade to 95 percent or more of the maximum density. Where the height of the embankment is greater than 5-feet, disc all organic matter thoroughly before constructing embankment.

3. Scarify existing roadways containing granular material within 3-feet of the subgrade 6-inches deep. Compact to the specified embankment density in accordance with AASHTO T99 and AASHTO T310. Compact the subgrade to 95 percent or more of the maximum density.

D. Existing Roadways.

1. Treat existing roadway surfaces lying less than 5-feet below the final grade as follows:

   a. For 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, scarify 6-inches deep and recompact unless otherwise required by the contract.

   b. For 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 less than or equal to 5-feet from the final grade, remove the underlying surfaces and base materials, scarify to a depth of 6-inches, and compact.

2. Existing roadway surfaces lying more than 5-feet below the final grade may remain in place except for bituminous material 12-inches and less above the zone of frequent soil saturation.

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

   a. Break bituminous material into pieces with a maximum surface area of 1 square foot and compact.

   b. Break up and compact PCC into pieces with a maximum surface area of 1 square yard with a pavement breaker or other approved equipment. The Department may restrict use of certain heavy equipment in heavy residential areas.

E. Placement of Embankment Material.

1. Place material in level lifts of loose material, no greater than 8-inches deep. Deposit and spread lifts parallel to the centerline and extending the full width of the embankment. If required, disc each lift to ensure uniform distribution of moisture and embankment materials. Compact each lift in accordance with the following before placing the next lift:

   a. 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.

   b. 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.

   c. Do not classify materials as unsuitable for embankment based on moisture content.

2. Place rock, bituminous material, or PCC obtained from the excavation for embankments in lifts equal to the average dimension of the material being placed. The maximum allowable dimension is 36-inches. Cut and dispose of exposed rebar. Distribute spalls and finer fragments to level and smooth each lift. Place rock, bituminous material, or PCC on the lift being constructed and push into place. Construct rock, bituminous material, or PCC lifts no closer than 24-inches below finished subgrade.

3. Proof roll lifts of soil, aggregate, or soil mixtures in accordance with Section 202.3.6. Correct instability discovered during the proof roll. After corrective measures, proof roll again to verify lift stability.

4. At the end of each working day of embankment placement, construct edge berms, interceptor berms, and embankment slopes as needed in the event of rain before work commences the following day. Extend temporary slope drains to connect to edge and interceptor berms.

F. Embankment Adjacent to Structures.

1. Compact embankment in accordance with Section 207.

2. In addition:

a. Do not place embankment materials in areas where piles are to be placed that contain rock, aggregate, broken concrete, or other material that would be retained on a 2 1/2-inch sieve and

b. Place at least 24-inches of compacted embankment over structures before placing rock, bituminous material, or PCC obtained from the excavation.

202.3.9 Compaction Procedures.

A. Start compaction or rolling at the edges and 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 T99 Method C Modified and AASHTO T310.

1. The Department will consider the ordinary use of trucks, carryalls, scrapers, tractors, or other construction equipment for compaction as long as the traffic of hauling equipment is evenly distributed over the fill.

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 of 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 PCC with a minimum of 6-passes of an approved roller.

202.3.10 Rock Excavation.

A. The Department will consider all material the contractor cannot excavate without blasting or using rippers, and all boulders and detached stones with a volume of 1/2 cubic yard or greater, as rock excavation. The classification "Rock Excavation" shall not apply to soft disintegrated rock, bituminous pavements, gravel, broken stone, or concrete pavements and structures. These and other materials are classified as normal excavation and are included under Section 202.3.3. Drain pockets left in the surface of the rocks before backfilling. Embank excavated rock in accordance with Section 202.3.8 or dispose in accordance with Section 106.8.

B. Roadway.

1. Excavate material classified as rock to a depth between 6 and 12-inches below subgrade.

2. Place in accordance with Section 202.3.8.E to subgrade.

3. Compact in accordance with Section 202.3.9 to subgrade.

C. Blasting.

1. The Department will call a blasting conference at least 14-days before blasting. Before this conference, submit blasting methods, a schedule, and the proposed protection for ensuring safety during blasting operations.
2. Assume responsibility for all damage due either directly or indirectly from the blasting operations. The Department will not allow excessive blasting or "over shooting." Remove and replace with approved backfill material all material outside the limits shown on the contract that is shattered or loosened by blasting.
3. When drilling and blasting, take precautions to preserve the rock in the finished slope in a natural undamaged condition with surfaces remaining reasonably straight and clean. If the blasting operation does not result in the slope conditions called for in the contract, modify operations until blasting does produce the required slope conditions.
4. Presplit rock when specified. Plan diameter, spacing, and loading of presplitting holes to produce a neat break ensuring that subsequent blasting and excavation do not affect the backslope face. Drill presplitting holes to the full depth of the ledge.
5. Demonstrate to the engineer with a 100-foot test section that diameter, spacing, and loading will produce an acceptable backslope. If the engineer finds the backslope acceptable, continue presplitting. Establish test sections until the engineer finds the results satisfactory.
6. Drill blast hole depth to the lesser of plan grade, or lifts of not more than 25-feet.
7. If drilling in benches, the Department will allow an offset not to exceed 18-inches 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.
8. Schedule rock excavation operations within 100-feet of bridges or other large structures for completion before beginning structure work.
9. As the excavation for each lift progresses, remove all loose and unstable material, breakage, and slices, even if located beyond the payment lines indicated in the contract.

202.4 Method of Measurement.

202.4.1 Excavation and Embankment.

A. The Department will measure the excavation and embankment quantity by the cubic yard of excavated material.

B. The Department may compute the volume by any of the following methods:

1. The method of average end areas measured by cross-sections taken by the Department at regular intervals and at breaks in grade.
2. Comparison of electronic surveyed surfaces.
3. Other means as determined by the engineer.

C. The Department will measure all excavation in its original position, except topsoil.

D. The Department will measure topsoil in its original position or in a stockpile after excavation, at the discretion of the engineer.

E. The contractor may remove and stockpile topsoil from fill areas separately for the Department to measure by cross-sectioning or the Department may measure topsoil quantity by cross-sectioning the area of removal before and after the contractor strips the topsoil.

F. The Department will not measure excess excavation generated by the contractor from other items that are stockpiled for use at a later date. The Department will measure excess excavation generated by others by the cubic yard in the stockpile.

G. When the contract indicates Item 202000 as a fixed quantity, the Department will measure and pay for this work in accordance with Section 109.7.

H. The Department will not measure embankments.

I. The Department will not measure material used to fill and plug existing pipes that the engineer has approved to be abandoned in place.

J. The Department will not measure removal of pipe and underdrain, including removal below and outside the limits of excavation, regardless of depth.

202.4.2 Undercut Excavation.

A. The Department will measure the quantity of undercut excavation in cubic yards of all excavated material computed by the average end area method.

B. The Department will not measure replacement of subgrade or foundation material, when chosen by the contractor instead of following the construction preparation procedures described in Section 202.3.7, as undercut excavation.

C. The Department will measure undercut areas that the contractor re-excavated as directed by the engineer that were not re-excavated due to the contractor's methods of operation.

202.4.3 Rock Excavation.

A. The Department will measure the quantity of rock excavation for roadway in cubic yards.

B. The Department will measure the volume of rock excavation to the limits of excavation required by the contract or as adjusted by the engineer based on exposing the rock to perform cross-sections or topographical surveys before and after excavation.

C. The Department will not measure rock excavated from depths in excess of 12-inches below the subgrade. The Department will measure material used for backfilling the excavated areas under its appropriate section, within the limits established by the section.

202.5 Basis of Payment.

202.5.1 Excavation and Embankment.

A. The Department will pay the quantity of:

1. Excavation not included under other sections in accordance with Section 202.

2. Excavation at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

a. Removing all pipes within the limits of excavation and all obstructions within the limits of construction in accordance with Section 202.3.4 that were not paid under other sections;

b. placing and compacting backfill material for voids created by obstruction removal;

c. placing embankment in accordance with Section 202.3.8;

d. excavating, placing and disposing of material in accordance with Section 202.3.3.

e. excavating bituminous concrete pavement;

f. disposing of surplus and unsuitable material;

g. subgrade preparation;

h. cleaning and clearing ditches of obstructions;

i. stockpiling excess topsoil and loading excess topsoil into state vehicles and removing and disposing as directed by the engineer;

j. placing and compacting material in fill areas after excavating;

k. stockpiling and re-handling of excavated material;

l. proof rolling;

m. correcting unstable lifts of fill, including providing and operating the loaded 10-wheel dump truck; correcting moisture content; aerating, discing, recompacting, and removing material; and providing and placing replacement material;

n. mixing material;

o. constructing temporary ditches from the cut for the pavement structure and for maintaining drainage during earthwork operations;

p. using excess excavation from utility company work;

q. constructing and maintaining haul roads and for restoring haul roads;

r. dewatering; and

s. dust control.

B. Material generated and stockpiled by others, in accordance with Section 202.3.3, at the contract unit price per cubic yard when the contractor excavates from the stockpile for use on the project.

C. Excavating and stockpiling topsoil only once, at the time of its initial excavation. The Department will pay for re-handling, disposal, transporting, or other related costs in accordance with Section 908.

1. If topsoil is stockpiled for cross sectioning, keep stockpiles separated from piles generated for cut areas. Failure to properly separate these piles will void payment for topsoil removed in fill areas.

D. The Department will pay for:

1. Imported borrow in accordance with Section 209.

E. The Department will make no separate payment for:

1. The construction of, maintenance of, materials used to construct, removal of, and final restoration of haul roads except for bridges across wetlands as identified in the contract.

2. The construction of temporary edge berms and interceptor berms to drain the site during excavation operations.
3. Material used for filling and plugging existing pipes.
4. Removal of pipe and underdrain, including removal below and outside the limits of excavation.
5. Cleaning new or existing pipes, culverts, or drainage structures.

202.5.2 Undercut Excavation.

A. Undercut excavation for correcting unstable subgrade or embankment foundation at the contract unit price per cubic yard. However, the unit bid price for undercut excavation, as defined here, shall not exceed 150 percent of the unit bid price per cubic yard for the excavation and embankment item. Before award, the Department will subtract from the contract bid price for this item any portion that exceeds the limit set forth in this section. Price and payment will constitute full compensation for:

1. Excavation;
2. preparation; and
3. placing and compacting backfill.

B. The Department will pay for:

1. Borrow in accordance with Section 209.
2. Removal of obstructions designated in the contract in accordance with Section 211.

C. The Department will make no separate payment for the replacement of subgrade or foundation material when chosen by the contractor instead of following the construction preparation procedures in accordance with Section 202.3.7.

202.5.3 Rock Excavation.

A. The Department will pay the quantity of rock excavation for roadway at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

1. Drilling, blasting, and presplitting;
2. excavating, removing rock, and placing and compacting backfill materials within the area between the subgrade and 12-inches below the subgrade;
3. hauling and disposing of surplus material;
4. draining pockets in the surface of the rock; and
5. removing shattered or loosened material and replacing it with approved backfill material.

B. The Department will not pay for rock excavation that is more than 12-inches beyond the plan subgrade elevation. The Department will not pay for backfill or backfilling areas between the bottom of the proposed subgrade and 12-inches below the proposed subgrade.

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

202003	UNDERCUT EXCAVATION	CY
202004	UNDERCUT EXCAVATION, PATCHING	CY

SECTION 203 — CHANNEL EXCAVATION

203.1 Description.

This work consists of excavating to widen, deepen, realign, reconstruct, reconfigure, shape, or finish channels, stream beds, and stream banks.

203.2 Materials.

Not applicable.

203.3 Construction.

A. Complete work in accordance with Section 202.3.

B. Comply with Section 909.3.

C. Use excess suitable material in embankment or fill areas in accordance with Section 202.3.8.

D. Dispose of unsuitable excavated material in accordance with Section 106.8.

203.4 Method of Measurement.

The Department may compute the volume by any of the following methods:

A. The method of average end areas measured by cross-sections taken at regular intervals and at breaks in grade.

B. Comparison of surveyed electronic surfaces.

C. Other means as determined by the engineer.

D. The Department will not measure material removed outside the payment limits, unless the engineer directed the work.

203.5 Basis of Payment.

The Department will pay for channel excavation at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

A. Excavating, hauling, depositing, and grading excavated materials;

B. shaping and finishing channel and stream beds and stream banks;

C. stockpiling excess suitable material if called for; and

D. disposing of excess and unsuitable materials.

ITEM	DESCRIPTION	UNIT
203000	CHANNEL EXCAVATION	CY

SECTION 204 — TEST HOLES

204.1 Description.

This work consists of excavating to locate underground utilities.

204.2 Materials.

Not applicable.

204.3 Construction.

A. Determine existing underground utility type, size, depth, and condition.

B. Excavate and backfill holes using equipment approved by the engineer. Take care not to damage wrappings, coatings, or other protective coverings on existing utilities.

204.4 Method of Measurement.

The Department will measure test holes by the cubic yard.

204.5 Basis of Payment.

A. The Department will pay for test holes at the contract unit price per cubic yard. Payment will constitute full compensation for excavating and backfilling test holes.

B. The Department will pay for:

1. Removal of existing pavement in accordance with Section 202.
2. Temporary roadway patch in accordance with Section 401.

ITEM	DESCRIPTION	UNIT
204000	TEST HOLE	CY

SECTION 207 — STRUCTURAL EXCAVATION AND BACKFILLING

207.1 Description.

This work consists of excavation and backfilling for placement of structures and pipes.

207.2 Material.

Borrow	Section 209 and Section 1001

207.3 Construction.

A. Structural and Pipe Excavation.

1. Handle excavated material in accordance with Section 202.3. Dispose of unsuitable material and other obstructions in accordance with Section 106.8.
2. Remove unsuitable material below the foundation elevation as directed by the engineer, as extra depth excavation.
   a. The type of backfill material below the foundation elevation will be as directed by the engineer.
3. The engineer will inspect the footing area after excavation is complete. Place concrete or precast units after the engineer approves the stability of the foundation material.

B. Shoring.

1. Provide shoring in accordance with Section 604.3.6, Section 604.3.7, and when required by OSHA standards.
2. Remove temporary shoring and bracing upon completion of the work, unless otherwise noted in the contract.

C. Rock Excavation for Structures and Pipe Trenches.

1. The Department will consider all material the contractor cannot excavate without blasting or using rippers, and all boulders and detached stones with a volume of 1/3 cubic yard or greater, as rock excavation. The classification "Rock Excavation" shall not apply to soft disintegrated rock, bituminous pavements, gravel, broken stone, or concrete pavements. These and other materials are classified as normal excavation and are included under Section 202.3.3. Drain pockets left in the surface of the rocks before backfilling.
2. Excavate material classified as rock as follows:
   a. For structures, a width of 24-inches outside of the neat line and a depth of 12-inches below the subgrade.
   b. For pipe trenches, a width of 18-inches from each side of the outside wall of the pipe and a depth of 12-inches below the pipe invert.
3. Complete required blasting in accordance with Section 202.3.10.C.

D. Backfilling

1. Backfilling is placing materials as defined in the contract above the bedding material and below the subgrade of the pavement structure or the ground elevation.

2. Place and compact borrow in accordance with Section 202.3.8 and the following:

   a. Place and spread backfill material in uniform horizontal lifts no greater than 8 inches loose measurement. Compact to 95 percent or more of the maximum density before placing the next lift. Submit requests to increase lift thickness to the engineer for approval. Maintain proper moisture content to achieve the required density.

   b. Compact backfill material without causing damage or 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 compaction does not create unbalanced stresses on the structure.

   c. When backfilling over structures, use heavy mechanical compacting equipment only after placing a minimum of 24-inches of cover over the structural unit or in accordance with the structure manufacturer's recommendations.

207.4 Method of Measurement.

A. Structural and Pipe Excavation

1. The Department will measure excavation in cubic yards of material excavated within the payment limits as follows:

   a. Excavation volume is limited by vertical planes located 24-inches outside of the neat line perimeter of the vertical faces of the structural element and 18-inches outside of the pipe.

   b. The upper limit as the lowest combination of the following:

      i. The existing ground surface;

      ii. the bottom of roadway excavation;

      iii. the bottom of channel excavation; and

      iv. excavation incidental to removal of structures and obstructions.

   c. The lower limit as the bottom of the pipe bedding or as the bottom of the structural foundation as shown on the plans.

   d. Place pipes in fill in accordance with Section 601.3.2.

2. The Department will not measure excavation of material outside the payment limits as defined above, unless the engineer directed excavation beyond the specified limits.

3. The Department will measure extra depth excavation in linear feet below the bottom of the pipe bedding or structural foundation as shown on the plans.

B. Temporary Shoring and Bracing

1. The Department will not measure temporary shoring or bracing.

C. Rock Excavation for Structures and Pipe Trenches

1. The Department will measure the quantity of rock excavation for structures and pipe trenches in cubic yards.

a. The Department will measure the volume of rock excavation to the limits of excavation required by the contract or as adjusted by the engineer based on exposing the rock to perform cross-sections before and after excavation.

b. The Department will not measure rock excavated from depths in excess of 12-inches below the pipe invert or bottom of footing.

D. Providing Structural Backfill

1. Providing of structural backfill will be measured in cubic yards. Backfill will not exceed 1.3 times the volume determined by the backfilling template.

E. Structural and Pipe Backfilling

1. The Department will measure backfilling in cubic yards of material backfilled within the payment limits as follows:

a. defined in 207.4.A.1.a, less the volume of any structures or pipes.

b. The upper limit will be finished grades minus depth of riprap or pavement.

c. The lower limit will be a combination of the top surface of the foundation stabilization or bedding and the top surface of structures or pipes.

207.5 Basis of Payment.

A. The Department will pay the quantity of:

1. Structural and pipe excavation at the contract unit price per cubic yard. Price and payment constitute full compensation for:

a. Excavating, hauling, storage, stockpiling and reuse, and disposing of excavated materials;

b. placing and removing shoring or bracing;

c. material excavated or backfilled outside of the payment limits;

d. temporary shoring and bracing left in place

e. removing existing pipe within the excavation template; and

f. dewatering.

2. Rock excavation for structure and pipe trench rock excavation at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

a. Drilling, blasting, and presplitting;

b. excavating, removing rock, and placing and compacting backfill materials within the template area;

c. hauling and disposing of surplus material;

d. draining pockets in the surface of the rock; and

e. removing shattered or loosened material and replacing it with approved backfill material.

3. Providing structural backfill in accordance with section 209 at the contract unit price per cubic yard. No payment will be made for backfill material generated under Section 207.

4. Structural and pipe backfilling at the contract unit price per cubic yard. The Department will consider that price and payment as constituting full compensation for placing and compacting all approved backfill.

B. The Department will not pay for rock excavation that is more than 12-inches below the pipe invert. The Department will not pay for backfill or backfilling areas between the over excavated subgrade and 12-inches below the proposed pipe invert.

C. When the engineer requires extra depth excavation beyond the prescribed limits, the Department will pay the unit price plus the additional percentage according to the pay limits provided in Table 207.5 -1 below.

Table 207.5 -1. Payment for Additional Excavation Depth

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

ITEM	DESCRIPTION	UNIT
207001	PIPE, CULVERT AND STRUCTURE BACKFILLING	CY
207002	PIPE, CULVERT AND STRUCTURE EXCAVATION	CY
207010	ROCK EXCAVATION FOR STRUCTURES AND TRENCHES	CY
207011	ROCK EXCAVATION FOR STRUCTURES AND TRENCHES (FIXED PRICE)	CY
207020	STRUCTURAL BACKFILL, BORROW TYPE B, PROVIDING ONLY	CY
207021	STRUCTURAL BACKFILL, BORROW TYPE C, PROVIDING ONLY	CY

SECTION 208 — FLOWABLE FILL

208.1 Description.

This work consists of providing and placing flowable fill.

208.2 Materials.

A. Flowable Fill Section 1047.1

B. Mortar Section 1047.6

C. Submit material sources to the engineer at least 30 calendar days before use.

D. Submit material test data of fly ash, representative of the source, to the engineer at least 30 calendar days before 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.

208.3 Construction.

208.3.1 Plant and Equipment Requirements.
Provide flowable fill produced only in batching plants in accordance with Section 1022.

208.3.2 Transportation.
Transport flowable fill in ready-mix trucks or as approved by the engineer. Place the flowable fill within 3-hours of mixing water with the dry materials.

208.3.3 Placement.

A. Plug downstream pipe end with brick and mortar. Flowable fill the pipe in such a way that both ends of the pipe are sufficiently plugged upon completion of the work.

B. Place flowable fill only when the ambient temperature is a minimum of 40 degrees F and rising.

C. Place when the temperature of the flowable fill is no less than 50 degrees F.

D. Do not place flowable fill against frozen surfaces.

E. Protect flowable fill from freezing for at least 36-hours in accordance with Section 501.3.6.

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. Ensure that all interior items can withstand the lateral hydraulic pressures of the flowable fill. The maximum allowable lift is 5-feet deep unless otherwise directed by the engineer. Allow each lift to cure until it is self-supporting before placing additional lifts or other loads.

H. Take care to prevent pipes from floating with the use of straps, soil anchors, or other approved means of restraint required to ensure proper alignment when using flowable fill as backfill for pipes.

I. 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 or running water.

208.4 Method of Measurement.

A. The Department will measure the number of cubic yards of material accepted and placed within the approved limits of the fill location. The Department will measure pipe trenches in accordance with Section 207.4.

B. The engineer will measure flowable fill for abandoned structures by the truck in accordance with Section 109.1.

208.5 Basis of Payment.

The Department will pay for flowable fill at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

A. Providing flowable fill mixture materials and designing, mixing, and hauling the flowable fill;

B. preparing the fill;

C. anchoring items within the fill; and

D. protecting and curing the fill after placement.

ITEM	DESCRIPTION	UNIT
208000	FLOWABLE FILL	CY

SECTION 209 — BORROW

209.1 Description.

This work consists of providing and placing borrow material from approved offsite borrow sources.

209.2 Materials.

Borrow	Section 1001

209.3 Construction.

209.3.1 Borrow Sources.

A. Provide an offsite borrow source.

B. Notify the Department's Materials and Research Section at least 10 working days before removing material from an offsite borrow source. Submit a description of the approved material limits within the offsite borrow source and the method of excavation for approval by the Department's Materials and Research Section.

C. Clear and grub the ground surface at the offsite borrow site in accordance with Section 201.

D. Strip off unsuitable material, as determined by the engineer, before excavating borrow.

E. The Department will not allow borrow excavation within 100 feet of the right-of-way lines without the engineer's written permission.

F. Submit a physical control plan to the engineer after the Department has tested and approved the borrow source, and removed the overburden. Implement the physical control plan and obtain approval before the Department cross-sections the source. Control methods may include fencing, earth berms, guardrails, or other physical barriers. If the offsite borrow source is fenced, provide a padlocked gate at the entrance. The Department will retain the padlock key.

G. Upon completion of the offsite borrow excavation, leave the offsite borrow area in a condition that allows accurate measurement. Prevent water from collecting or standing within the excavated borrow area.

209.3.2 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. The Department will sample and test the offsite borrow source.

209.3.3 Borrow Placing and Compacting.

Place and compact borrow in accordance with Section 202.3.8.

209.3.4 Providing Borrow for Utility Backfill.

A. When providing backfill material for utility trenches, stockpile materials at locations mutually agreed to by the contractor, the utility, and the engineer.

B. Coordinate the operation of backfilling utility trenches with the utility organizations. The utility organizations involved will backfill utility trenches in accordance with Section 202.3.8. The Department will not require proof rolling.

209.3.5 Providing and Stockpiling Borrow.
Provide and stockpile borrow in accordance with the contract.

209.4 Method of Measurement.

A. The Department will measure borrow material in cubic yards. The Department will measure borrow volume at the source, in its original position by cross-sections and computed by the method of average end areas or electronic surface comparison. The Department will not include overburden or stripping material in the borrow measurement.

B. The contractor may alternatively request the Department to weigh the material and convert the weight to cubic yards. If the Department approves the request, the Department will provide the approval to the contractor in writing. The Department and the contractor shall agree on the conversion factors from weight measurement to volumetric measurement before using the alternative method.

C. Where the engineer determines that obtaining weight and volume conversion factors for the borrow types specified is not practical, the Department will consider 1 cubic yard to weigh 3,050-pounds.

D. Unless stated otherwise, the Department will calculate the weight of borrow material in accordance with Section 109.1.

E. The Department will measure borrow material provided and stockpiled for utility companies or others using the borrow source tickets only.

209.5 Basis of Payment.

The Department will pay for borrow at the contract unit price per cubic yard or ton. Price and payment will constitute full compensation for all Work.

ITEM	DESCRIPTION	UNIT
209001	BORROW, TYPE A	CY
209002	BORROW, TYPE B	CY
209004	BORROW, TYPE C	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
209011	BORROW, TYPE B, PROVIDING ONLY	TON
209012	BORROW, TYPE C, PROVIDING ONLY	TON
209013	BORROW, TYPE F, PROVIDING ONLY	TON

SECTION 211 — REMOVAL OF STRUCTURES AND OBSTRUCTIONS

211.1 Description.

This work consists of removing items designated for removal in the contract.

211.2 Material.

Borrow Section 1001

211.3 Construction.

211.3.1 General.

A. Dispose of material in accordance with Section 202.3.3. Complete blasting and other operations that may damage new construction before constructing new work. When backfilling cavities within the proposed roadway box, use Borrow Type C. When backfilling cavities outside of the proposed roadway box, use Borrow Type F.

B. Saw cut concrete pavement, sidewalks, curbs, gutters, and similar structures to a true vertical line or remove to an existing joint in accordance with Section 762.

211.3.2 Removal of Bridges, Culverts, Drainage Structures, Obstructions, and Foundations.
Completely remove existing structures except for deep foundations. Remove deep foundations to 24-inches below proposed ground surface elevation.

211.3.3 Removal of Fences and Guardrail.
Remove fences and guardrails designated for removal by the contract.

211.3.4 Removal of Existing Portland Cement Concrete Pavement, Curb and Sidewalk.
Obtain approval from the engineer for the type of power breaking machines or other equipment planned for use. The Department will not allow used of a ball-type breaker machine. Break only what can be removed in a single working day, unless otherwise approved by the engineer. Ensure no damage occurs to the subbase or existing buried, surface, or aerial utilities.

211.3.5 Disposal.
Dispose of excess or waste material in accordance with Section 106.8.

211.4 Method of Measurement.

A. The Department will measure the quantity of removed existing PCC pavement, curb, and sidewalk in square yards along the top surface of the materials before removal, as projected on the horizontal plane.

B. The Department will measure the quantity of guardrail and fence from the center of end post to the center of end post including the limits of payment in accordance with the Standard Construction Details for barrier connections and end treatments.

C. The Department will not measure removal of structures and obstructions when the pay item is a lump sum.

211.5 Basis of Payment.

The Department will pay for removal of structures and obstructions, removal of PCC pavement, curb, and sidewalk, and removal of guardrail and fence at the contract unit price. Price and payment will constitute full compensation for removing and disposing of structures and obstructions, PCC pavement, curb, and sidewalk, and guardrail and fence designated for removal. The Department will not make separate payment for excavating, backfilling, and compacting cavities resulting from structure removals or salvaging, storing, and protecting materials in the right-of-way.

ITEM	DESCRIPTION	UNIT
211000	REMOVAL OF STRUCTURES AND OBSTRUCTIONS	LS
211001	REMOVAL OF PCC PAVEMENT, CURB, AND SIDEWALK	SY
211002	REMOVAL OF GUARDRAIL AND FENCE	LF

DIVISION 300 — BASE COURSES

SECTION 301 — GRADED AGGREGATE BASE COURSE

301.1 Description.

This work consists of constructing GABC on a prepared subgrade or subbase.

301.2 Materials.

A.	Coarse Aggregate	Section 1004
B.	Graded Aggregate	Section 1005

301.3 Construction.

A. Shape the subgrade to grade and cross section in accordance with the contract and Section 202.3.5.

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

C. Place graded aggregate material in successive layers, with a maximum layer thickness of 8 uncompacted inches to prevent segregation and with a maximum surface deviation of 1/2-inch in 10-feet.

D. Compact each layer to 98 percent or more of the laboratory maximum density in accordance with AASHTO T99 Method C, Modified, and T310.

1. If bituminous millings are used as GABC within the roadway pavement box, compact with a sheepsfoot roller to the satisfaction of the engineer.

E. When using GABC from different sources, keep materials for a single project in separate stockpiles. The contractor and engineer must agree on placement limits when the contractor plans to use multiple material sources. Ensure that each area of base course constructed is from a single source for full depth placement within agreed limits.

F. The Department will not allow Recycled Concrete Aggregates (RCA) as the final project surface.

301.4 Method of Measurement.

A. The Department will measure the total quantity of material from all sources as the number of cubic yards or tons of GABC placed and accepted. The Department will determine weight in accordance with Section 109.1.

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

301.5 Basis of Payment.

A. The Department will pay for GABC and recycled material at the contract unit price per cubic yard or ton for preparing, providing, placing, and compacting all materials. The Department will make no additional payment for work performed to bring recycled concrete aggregate or bituminous concrete millings into compliance with requirements specified in Section 1005.

B. If the contractor generates recycled GABC from materials milled or excavated under other items in the contract, the Department will make payments under the milling or excavating items and the GABC item.

ITEM	DESCRIPTION	UNIT
301001	GABC	CY
301002	GABC PATCHING	CY
301003	GABC	TON
301004	GABC PATCHING	TON
301005	RECYCLED CONCRETE AGGREGATE	CY
301006	RECYCLED ASPHALT PAVEMENT	CY
301007	RECYCLED CONCRETE AGGREGATE	TON
301008	RECYCLED ASPHALT PAVEMENT	TON

SECTION 302 — STONE

302.1 Description.

This work consists of providing, placing, and compacting stone.

302.2 Materials.

A. Coarse Aggregate Section 1004

302.3 Construction.

A. Shape the subgrade to grade and cross section in accordance with Section 202.3.5.

B. Place material so that no segregation occurs. Use rollers or compactors.

C. Place stone in successive layers, with a maximum layer thickness of 8 uncompacted inches to prevent segregation.

D. Consolidate each layer with vibratory equipment.

E. Remove and dispose of stone used in temporary construction as directed by the engineer.

302.4 Method of Measurement.

The Department will measure stone as the number of tons of stone placed and accepted. The Department will determine weight in accordance with Section 109.1.

302.5 Basis of Payment.

The Department will pay for stone at the contract unit price per ton. Price and payment constitute full compensation for preparing, providing, placing, and compacting all materials.

ITEM	DESCRIPTION	UNIT
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

401.1 Description.

This work consists of providing, placing, and compacting bituminous pavement.

401.2 Materials.

A.	Release Agents	Section 1010
B.	Tack Coat	Section 1011
C.	Thin Lift Tack Coat	PG 64-22
D.	Asphalt Production	Section 1014
E.	Joint Sealant	Section 1042.1.B

401.3 Construction.

A. Before 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 & Research Section, and other appropriate parties.

B. Mix Design.

Develop the JMF in accordance with Section 1014 and submit test results for review a minimum of 30 calendar days before application. Include aggregate type and gradation and percentages of polymer-modified emulsion, water, and cement by dry aggregate weight.

C. Delivery of Mixture.

Deliver no less than 100 tons per hour to the project site or as approved by the engineer.

D. Hauling Equipment.

1. Provide trucks with tight, clean, smooth, metal beds thinly coated with an emulsified oil, soap solution, or other approved release agent to prevent the bituminous mixture from adhering to the truck bed.
2. Ensure that truck beds have no holes or cracks and are free from debris.
3. Provide truck bed tarps made of canvas or other waterproof material, and free of rips, tears, and holes, that will cover the truck bed from front to back and will overlap the sides and rear of the truck body.
   a. Fasten the front of the tarp to the truck body and protect the fastening using an air foil or air dam.
   b. Use a minimum of 3 straps on the sides to hold the tarp over the sides of the body. If the tarp does not reach over the back of the body, straps on the rear of body are also required.

E. Paver.

1. Use a self-propelled unit with a screed or strike-off assembly that automatically controls grade leveling and slope, is heated, and is capable of spreading and finishing bituminous pavement materials to the specified lane widths and thicknesses.
2. Equip the paver with an attachment that confines the material at the end of the gate and extrudes the asphalt material to form a compacted wedge-shaped pavement safety edge.
3. Equip the paver with a tack spray application system for thin lift paving operations.

F. Rollers.

1. Provide a self-propelled static or vibratory steel wheel type roller equipped with scrapers or a pneumatic-tire oscillating type roller equipped with smooth tires of equal size and diameter.
2. Use rollers equipped with a system for moistening each wheel or roller while in use.
3. Use a number and weight of rollers sufficient to compact the mixture to the required density without crushing aggregate or displacing the mixture.
4. Do not use rollers that mar the surface.

G. Weather Limitations.

1. Place bituminous pavement materials only when the surface is dry and unfrozen, and the weather is not foggy or rainy. The Department will consider the presence of frost particles in the roadbed or on the surface as a reason to prohibit placement.
2. Do not place subsequent lifts, release materials, or open to traffic until the mat temperature is below 140 degrees F.
3. The Department will not allow placement of bituminous concrete when the air temperature at the paving location is below the temperatures indicated in Table 401.3-1 below.

Table 401.3-1. Minimum Ambient Air Temperature for Placement of Types of Bituminous Concrete

Material Type	Temperature
BCBC	32 ° F
B	32 °F
C	40 °F
Stone Matrix Asphalt, Thin Lift, and Wedge Lift	50 °F

H. 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 the mixture will contact.

I. Tack Coat.

1. Dry and broom-clean surface ahead of tack coat application.
2. Use a distributor designed, equipped, calibrated, maintained, and operated to apply material uniformly on surfaces with varying widths and up to 15-feet wide. Provide a distributor capable of maintaining a uniform distributing pressure and controlling the application rate. Distributor is

to be equipped with a tachometer, pressure gauges, accurate volume-measuring devices or a calibrated tank, a thermometer for measuring temperatures of tank contents, a power-operated pump, and full circulation spray bars with lateral and vertical adjustments. Provide nozzles according to the manufacturer's recommendations for the material selected for application. Use hand-spraying equipment for small areas or locations with irregular shapes. Maintain distribution equipment in accordance with the manufacturer's recommendations. Store distributor tank cleaning records inside the distributor cabin and make records available to the Department upon request of the engineer.

3. Apply tack coat in advance of paving operation at a uniform coverage in accordance with the application rate shown in Table 401.3-2. Apply at a temperature in accordance with the manufacturer's recommendations.
4. Do not permit activity on the tack surface until the material has set per the manufacturer's recommendations, but no farther than needed for the current day's operation. Temperature, humidity, and dampness will affect the breaking and setting of all emulsions.
5. The engineer may test the application rate and residual application rate in accordance with ASTM D2995.

Table 401.3-2. Tack Coat Application Rates

Surface Type	Residual Rate (gallons per sy)	Application Rate, (gallons per sy)
New Asphalt	0.03 - 0.05	0.05 – 0.08
Existing (aged) Asphalt	0.05 - 0.07	0.08 – 0.11
Milled Surface (asphalt and PCC)	0.06 – 0.08	0.09 – 0.12
PCC	0.04 – 0.07	0.06 – 0.11

J. Placement.

1. Place the mixture in a continuous operation using an approved paver. The Department will not allow stopping the paver to adjust the attachment described in Section 401.3.E.2. at crossroads, driveways, or obstructions.
2. Ensure that the outside edges of pavement are in true alignment parallel to the roadway centerline with the longitudinal joint in the surface course at the lane line. Plan placement of the surface course to ensure that the longitudinal joints in the surface course are parallel to the lane lines and not in the wheel path of vehicles using the roadway. Conduct surface course paving operations to utilize the full lane width unless directed by the engineer. Make longitudinal joints parallel to the centerline unless otherwise specified in the contract. Place a longitudinal joint between the travel way and shoulder on the shoulder side with a 6-inch offset of the lane line. Establish and follow reference lines or other approved markings to control the true alignment of the longitudinal joints.
3. When paving multiple lifts or courses, offset individual successive lifts a minimum of 6-inches.
4. Place tack in the following locations:
   a. On the face of all vertical joints
   b. Between the base course and wearing course.
   c. Between subsequent bases courses.

d. If the subsequent base course is placed within 24-hours of the preceding course and the preceding course has not be subjected to traffic or precipitation, tack may be omitted.

5. If the contractor cannot complete spreading and compacting a full truck load of mixture by sunset, do not unload the truck unless the engineer has granted approval for nighttime paving.

K. Compaction.

Compact the bituminous pavement mixture after spreading, striking off, and correcting surface irregularities.

L. Compaction Testing.

1. Perform quality control of pavement compaction by testing in-place pavement density. The contractor is limited to taking a single core on the first day of paving or after the change of a JMF for gauge calibration. Repair core holes in accordance with 401699 - Quality Control/Quality Assurance of Bituminous Concrete.

2. The engineer will perform quality assurance testing, evaluate material production, and evaluate compaction quality in accordance with 401699 - Quality Control/Quality Assurance of Bituminous Concrete.

M. Joints.

Construct joints to meet surface and compaction requirements. Tack all vertical contact surfaces before placing new mixture against the surface. Except for joints created from newly placed adjacent passes, seal all new pavement joints that do not call for an overlay. Seal all joint openings. Submit the joint sealant material appropriate for the dimension off the opening for approval. For joint openings exceeding 1/4-inch width, the engineer may require corrective action. For butt joints, construct in accordance with Section 762.

N. Wearing Surface.

The maximum allowable longitudinal or transverse deviation is 1/4-inch in 10-feet. Provide a 10-foot straight edge for testing.

401.4 Method of Measurement.

A. The quantity of bituminous pavement materials will be measured as the actual number of tons placed and accepted. The weight will be calculated in accordance with Section 109.1.

B. The Department will not measure the safety edge.

401.5 Basis of Payment.

A. The Department will pay for the accepted quantity of bituminous pavement materials at the contract unit price per ton. Payment constitutes full compensation for:

1. Preparing the surface;

2. providing, preparing, and placing all materials, including tack coat, and safety edge;

3. removing material from around manholes, drainage valves, and similar features;

4. removing and replacing excess asphalt cement; and

5. constructing the safety edge.

B. The Department will pay for Superpave Type B, placed instead of Superpave Type BCBC, at the contract unit price for Superpave Type BCBC. The Department will make the asphalt cement cost adjustment based on the virgin asphalt of the Superpave Type B.

C. The Department will apply any incentive or disincentive pay adjustments as established by special provision 401699.

D. The Department will withhold the final 5 percent payment for the final riding surface until the rideability submission is made as established by special provision 401580.

E. The Department will not pay for corrective action as directed by the engineer for joint openings exceeding 1/4-inch width.

ITEM	DESCRIPTION	UNIT
401005	SUPERPAVE, TYPE C, 9.5 mm, PG 64-22 (CARBONATE STONE)	TON
401006	SUPERPAVE, TYPE C, 9.5 mm, PG 70-22 (CARBONATE STONE)	TON
401007	SUPERPAVE, TYPE C, 9.5 mm, PG 76-22 (CARBONATE STONE)	TON
401014	SUPERPAVE, TYPE B, PG 64-22	TON
401015	SUPERPAVE, TYPE B, PG 70-22	TON
401016	SUPERPAVE, TYPE B, PG 76-22	TON
401021	SUPERPAVE, TYPE BCBC, PG 64-22	TON
401029	SUPERPAVE TYPE C, 9.5 mm, PG 64-22, PATCHING	TON
401030	SUPERPAVE TYPE B, PG 64-22, PATCHING	TON
401031	SUPERPAVE TYPE BCBC, PG 64-22, PATCHING	TON
401036	SUPERPAVE TYPE C, 9.5 mm, PG 64-22, WEDGE	TON
401037	SUPERPAVE TYPE B, PG 64-22, WEDGE	TON
401044	SUPERPAVE TYPE C, 9.5 mm, PG 64-22 (NON-CARBONATE STONE)	TON
401045	SUPERPAVE TYPE C, 9.5 mm, PG 70-22 (NON-CARBONATE STONE)	TON
401046	SUPERPAVE TYPE C, 9.5 mm, PG 76-22 (NON-CARBONATE STONE)	TON
401047	SUPERPAVE TYPE C, 12.5 mm, PG 76-22 (NON-CARBONATE STONE)	TON
401053	SUPERPAVE TYPE C, 4.75 mm (THIN LIFT), PG 64-22,	TON
401054	SUPERPAVE TYPE C, 4.75 mm (THIN LIFT), PG 70-22,	TON
401055	SUPERPAVE TYPE C, 4.75 mm (THIN LIFT), PG 76-22,	TON

SECTION 403 — BITUMINOUS PAVEMENT MATERIALS FOR TEMPORARY ROADWAY MATERIAL

403.1 Description.

This work consists of providing and placing bituminous pavement as TRM.

403.2 Materials.

A. Cold Patch Section 1015

403.3 Construction.

Coordinate placement and compaction of TRM with all other work and operations necessary to maintain traffic safety.

403.4 Method of Measurement.

The Department will measure TRM by tons placed calculated in accordance with Section 109.1.

403.5 Basis of Payment.

The Department will pay for TRM at the contract unit price per ton. Payment constitutes full compensation for providing, preparing, placing, and removing materials.

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

SECTION 404 — BITUMINOUS CRACK AND JOINT SEALING

404.1 Description.

This work consists of sealing existing transverse joints, longitudinal joints, and pavement cracks in existing pavement, existing patches, or around new patch perimeters.

404.2 Materials.

A.	Crack Sealant	Section 1042.1.A
B.	Joint Sealant	Section 1042.1.B

404.3 Construction.

404.3.1 Sealant Equipment.
Use sealing equipment specifically recommended by the sealant manufacturer.

404.3.2 Refacing of Pavement.
Reface existing pavement using a router to expose sound pavement or cut the joint with a router to the width and depth necessary to provide the joint reservoirs shown in the contract.

404.3.3 Cleaning Before Resealing.

A. Following routing or refacing operations on newly constructed or existing joints, clean the pavement faces and openings with hot compressed air that is dry and oil free. Use compressed air equipment that delivers a continuous pressure of at least 100 pounds per square inch, measured at the source, to remove cuttings or debris remaining on the pavement faces or in the pavement openings.

B. Equip air compressors with traps capable of removing moisture and oil from the compressed air. Stop work when there is oil or moisture in the compressed air. Make necessary adjustments to the equipment until the air stream is free of contaminants before resuming work.

C. The Department will not allow placement of sealant if dust, moisture, or other contaminants are present on the pavement surface.

D. Protect the public from hazard or damage during the cleaning operations by shielding the work with rigidly supported plywood sheeting or other suitable material and methods subject to the engineer’s approval.

E. Take care not to damage the subbase, curbs, shoulders, load transfer devices, or pavement. If damage occurs, submit repair procedure for approval and perform repairs to the satisfaction of the engineer.

404.3.4 Limits of Crack and Joint Preparation.
Limit the final stages of joint preparation, including air pressure cleaning of joints, and placement of separating or backup material, to the length of joint that will be resealed during a day's production.

404.3.5 Installation of Hot-Poured Sealant.

A. Follow the manufacturer's recommendations for heating and applying the sealant. Provide a copy of the manufacturer's recommendations to the engineer.

B. Discard and dispose of the first gallon of material to flow out of the applicator wand at the beginning of the day.

C. Place sealant at a uniform, specified depth and thickness. Seal the cracks and joints uniformly so that upon completion of the work, the surface of the sealant material is 1/16 to 3/16-inch below the adjacent pavement surface. Remove excess material on the surface of the pavement. Do not allow traffic on the pavement in the area of the cracks and joints during the curing period.

D. Submit repair procedure for failed joints to the engineer for approval.

404.4 Method of Measurement.

A. The Department will measure the linear footage along the crack or joint from end to end.

B. The Department will not measure sealed overcuts and will consider these areas as incidental to the saw cutting item.

404.5 Basis of Payment.

A. The Department will pay for the accepted quantity of crack and joint sealing at the contract unit price per linear foot. Payment constitutes full compensation for:

1. Providing and placing hot-poured joint sealer;
2. joint sawing and refacing;
3. sandblast cleaning; and
4. air-blast cleaning.

ITEM	DESCRIPTION	UNIT
404001	BITUMINOUS CRACK AND JOINT SEALING LESS THAN 3/4-INCH WIDE	LF
404002	BITUMINOUS CRACK AND JOINT SEALING, 3/4-INCH TO 1 3/4-INCH WIDE	LF

DIVISION 500 — RIGID PAVEMENT

SECTION 501 — PORTLAND CEMENT CONCRETE PAVEMENT

501.1 Description.

This work consists of constructing PCC pavement.

501.2 Materials.

A.	Portland Cement Concrete Production	Section 1022
B.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7
C.	Joint Sealants	Section 1042.1.B
D.	Epoxy Grout	Section 1047.4
E.	Embedded Hardware:	
1.	Tie Bars	Section 1037
2.	Dowel Bars	Section 1037
3.	Tie Bolts - Hook Bolts or W-bolts	Section 1037

501.3 Construction.

A. Provide a flatwork technician with an ACI or NRMCA certification, or a certification from another program pre-approved by the Department, to supervise all concrete finishing work. Provide the flatwork certification to the engineer before placing concrete.

B. Slip-form or conventionally form the pavement unless otherwise specified. If the contractor uses slip-forms, construct small or irregular areas or areas inaccessible to the paver with fixed forms. The contractor may hand-finish these areas but must still meet the performance measures of Section 501.3.9. The Department will not allow dimensions less than 2-feet wide unless otherwise approved.

C. At least 10-days before paving, schedule a pre-paving meeting with representatives from the Department, the contractor, and others involved in, or affected by, the paving operations.

D. Submit a means and methods plan 5-days before the pre-paving meeting. Include the following in the plan:

1. Method of concrete placement;
2. concrete delivery schedule;
3. proposed width of paving pulls;
4. installation methods for embedded hardware;
5. typical locations of longitudinal sawed and construction joints;
6. method of transverse construction joint installation;
7. joint locations if different than shown in the contract;
8. detail for building a transverse construction joint at the end of the day’s paving run;

9. procedure, including the finishing screed, for forming and constructing small or irregular shaped portions of pavement;
10. construction for the safety edge;
11. method of installing and securing dowel bars and a template for use by the engineer;
12. Method of installing and securing tie bars and/or tie bolts;
13. procedure for final texturing of the pavement surface;
14. location of the concrete delivery trucks in relation to the paving area and the proposed haul route from the concrete plant;
15. hand finishing procedures and tools, including a misting or fogging device;
16. contingency plan and protective covering for rain events;
17. proposed subcontractors;
18. proposed thermal protection plan for placing concrete during extremely hot or cold conditions; and
19. Class B/SF mix design for slip-form paving and Class B mix design for fixed form paving in accordance with Section 1022.

501.3.1 Construction.

A. Place and grade base course to the tolerance specified under the applicable specification. Do not place hardware on the grade until the engineer provides approval.

B. Provide and install load transfer assembly consisting of dowel bars and dowel support basket when identified as the dowl bar placement method in the means and methods plan. Clearly mark, on both sides of the pavement, the center of each load transfer assembly using paint, stakes, or other agreed upon methods to show that the transverse sawed joints are properly located. Construct load transfer assemblies in accordance with the contract. Apply a graphite coating to each dowel bar just before concrete placement. Cut the shipping or tie wires on the dowel support basket after staking. The engineer will check initial dowel bar placement on grade with a template or other approved tool provided by the contractor.

C. Provide and install tie bars, or tie bolts to tie pavement slabs together when new concrete lanes will be placed adjacent with new concrete lanes. Provide and install tie bars for tying into concrete lanes placed under previous contracts. Install these items during or before concrete placement and in accordance with the means and methods plan. Obtain approval for the installation method before beginning concrete placement.

D. Placing Concrete.

1. Wet the base course just before contact with the concrete. The application rate should not cause any pooling of water on the grade.
2. Avoid stopping the paver's forward movement.
3. Maintain a vertical pavement edge. If necessary, use extra finishers, temporary forms, or trailing forms as part of the paver.
4. 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. The

Department considers a roll of concrete covering approximately half of the distributing augers to be desirable. The contractor may use spreaders in advance of the paver to control the concrete supplied to the paver.

5. Build a transverse construction joint at the end of the day's paving run in accordance with the pre-paving meeting submittal.
6. Before 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, locate the full width of the paver tracks over the previously constructed pavement with no overhang across the pavement edge to prevent breaking. Use rubber facing, wood, or other approved protection if the paver tracks contact the existing pavement surface. Concrete in the completed lane must achieve a compressive strength of at least 2,000 pounds per square inch before placing adjoining pavement.
8. For small, irregular sections, or areas of pavement inaccessible to the paver:
   a. Use full depth wooden or steel forms.
   b. Place concrete directly onto a previously approved, moistened grade. Consolidate with hand vibrators taking care not to dislodge previously placed dowel bars, tie bars, or tie bolts or to contact 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 501.3.5 and 501.3.6.
   d. Remove forms when the concrete is self-supporting.
   e. Correct honey-combed areas.
   f. Maintain curing methods, in accordance with Section 501.3.6, in place for 5-days or until the concrete compressive strength reaches 2,000 pounds per square inch. If stripping forms sooner than 5-days following concrete placement, apply curing compound or extend other curing methods immediately.
9. Place a safety edge longitudinally along the pavement exterior edges. In PCC pavement sections, modify the paver screed to provide a chamfer at the end of the PCC pavement that forms a wedge-shaped pavement edge.

E. Finishing.

1. Produce a smooth, uniform, concrete surface with the paver screed conforming to the specified pavement cross slope and width.
2. Limit hand finishing to sealing surface tears, supporting non-vertical pavement edges, and to assist in the surface finish of small, irregular areas inaccessible to the paver. The Department will not allow steel trowels 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. The contractor may apply an evaporation retardant through the use of a previously approved misting or fogging device. The Department will not allow application of water shaken from brushes or applied through a hose.

5. Finish the final pavement surface before texturing by pulling a wet burlap drag in the longitudinal direction. Keep the burlap in a moist condition throughout the paving operation to prevent surface tearing.
6. Texture and cure the pavement in accordance with Sections 501.3.5 and 501.3.6.

501.3.2 Slip-Form Paving.

A. Equipment.

1. Use a track operated, self-propelled, slip-form paver that independently, or in conjunction with an advance concrete spreader, will do the following:
   a. Strike-off and screed concrete;
   b. adjust to produce the specified cross slope and pavement width;
   c. place a minimum 24-foot width of mainline pavement in 1 pull unless otherwise specified in the contract documents;
   d. operate using electronic grade controls for horizontal and vertical alignment;
   e. provide a vertical pavement edge with slump off not exceeding 1/4-inch, exclusive of edge rounding, when checked using a 10-foot straightedge;
   f. vibrate and consolidate the concrete for the full width of placement to produce uniform concrete consolidation throughout the entire slab;
   g. automatically stop when forward movement of the unit is interrupted;
   h. provide a smooth, uniform concrete surface finish requiring minimal or no floating or hand finishing; and
   i. provide vibrators attached to the paving equipment or mounted on a separate carriage that do not contact dowel bars, tie bars, tie bolts, other embedded hardware, or forms. Equip with a dowel bar inserter (DBI) if approved in advance by the engineer.

B. Concrete Saws.

Provide mechanical saws capable of producing joints in accordance with the Standard Construction Details. Determine the number of saws needed based on weather, temperature, and amount of pavement placed. Provide backup equipment and lighting, if necessary, on site before beginning concrete placement.

C. Work Bridge.

Provide platforms spanning the full width of the paving pull for workers to finish, texture, and cure the concrete. Provide bridges that do not come in direct contact with the pavement surface.

D. Texturing.

Provide independently powered, self-propelled texturing equipment capable of adjusting the depth of tine penetration to produce the specified pavement surface texture.

E. Curing.

Provide mechanically powered equipment to place curing compound at the specified rate on the pavement surface and on all exposed edges. Use a fully atomized mechanical sprayer equipped with a tank agitator and wind guard. Obtain the engineer’s approval for the use of alternate curing methods.

F. Diamond Grinding.

1. Provide self-propelled machines equipped with gang-mounted diamond blades having a minimum cutting head width of 3-feet with 50 to 60 diamond blades per foot of cutting head.
2. Provide a cutting edge 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.

501.3.3 Fixed Form Paving.

A. Forms.

Use straight, metal forms a minimum of 10-feet long having adequate strength to support the equipment. Use solid forms without horizontal joints with a depth equal to or greater than the prescribed edge thickness of the concrete and a base width at least equal to the depth of the forms. The base width is not required to exceed 8-inches for deeper forms. Use flexible or curved forms for curves of 150-foot radius or less. The contractor may use approved straight forms of 5-foot lengths for curves of a radius from 75 to 150-feet. Obtain the engineer's approval for flexible or curved forms. The engineer may approve the use of wood forms in areas requiring hand finishing in accordance with Section 501.3.1.E.9.a. Secure the forms in place to withstand the impact and vibration of consolidating and finishing equipment without visible spring or settlement. Extend flange braces outward on the base a minimum of two thirds the height of the form. Remove forms with battered top surfaces or bent, twisted, or broken forms. Use repaired forms only after inspection and approval by the engineer. Use buildup forms only where the total area of pavement of any specified thickness on the project is less than 2,000 square yards. Ensure that the top face of the form does not vary from a true plane more than 1/8-inch in 10-feet and that the vertical face of the form does not vary by more than 1/4-inch. Make provisions for locking the ends of abutting form sections together tightly, and for secure setting.

B. Supplementary Rails.

1. Provide metal rails capable of secure attachment to the top of the side forms that provide a track that enables spreading, finishing, and curing equipment to back over the end of the previous day's run.
2. Provide metal rails of sufficient length to accommodate equipment the contractor needs to back out of the way. Provide rails of sufficient height that all wheels and flanges of wheels clear the previously placed concrete by at least 1/2-inch.

C. Base Support.

Provide a foundation under the forms so that the length and width of the form is firmly in contact with the grade.

D. Form Setting.

Stake forms into place with a minimum of 3 pins for each 10-foot section. Place a pin at each side of every joint. Lock form sections tightly to prevent play or movement in any direction. Do not deviate the form from true line by more than 1/4-inch at any point. The Department will not allow excessive settlement or springing of forms from the finishing machine's weight. Clean and oil forms before placing concrete.

E. Grade and Alignment.

Check the form alignment and grade elevations immediately before placing the concrete. Reset and recheck disturbed forms or areas of unstable grade.

F. Removing Forms.

The contractor may remove forms when the concrete is self-supporting.

501.3.4 Equipment.

A. In addition to the equipment included in this Section, use equipment listed under Section 501.3.2. Replace Section 501.3.2.A.2 with the following for fixed form paving:

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

   a. Strike-off;

   b. screed;

   c. adjustment to produce the specified cross slope and pavement width;

   d. placing a minimum 12-foot width of mainline pavement in 1 pull unless otherwise specified in the contract; and

   e. providing a smooth, uniform concrete surface finish requiring minimal or no floating or hand finishing.

B. Vibration.

1. Vibrate and consolidate the concrete for the full placement width. Attach vibrators to the paving equipment or mount on a separate carriage. Only operate the vibrators during forward motion of the machine. Operate hand vibrators no more than 10-seconds and no less than 5-seconds in any 1 location unless approved otherwise by the engineer. Place vibrators in the concrete and withdraw slowly in a vertical direction. To obtain concrete consolidation near the joint assemblies, the engineer may require hand vibration with an immersion spud vibrator. Prevent vibrators from contacting dowel bars, tie bars, tie bolts, other embedded hardware, or forms. Use the number and frequency settings of the vibrators to achieve uniform consolidation of the concrete throughout the entire slab thickness and width.

2. Use surface vibrators with a frequency of no less than 3,500 impulses per minute. Use internal type vibrators with a frequency of no less than 5,000 impulses per minute for tube vibrators and no less than 7,000 impulses per minute for spud vibrators. When using either hand-operated spud type internal vibrators, or spud-type internal vibrators attached to spreaders or finishing machines adjacent to forms, ensure that these vibrators have a frequency of no less than 3,500 impulses per minute. Always provide an impulse calibrator for verification of vibrator impulses. When using the existing pavement to support the finishing machine instead of a form, adjust the wheels of finishing machines to provide full bearing on the pavement and extended to prevent breaking the pavement edge.

C. Excavate form lines for all forms supporting mechanical finishing equipment using a machine designed for this purpose and approved by the engineer or use an approved machine that concurrently trims the subgrade or subbase to grade.

D. When it is necessary to operate 1 or both sets of paving machine wheels or tracks on previously placed concrete, ensure that the wheels or tracks bearing on the concrete stay at least 3 inches from the previously placed pavement edge. The contractor may double flange the wheels when operating with 1 side of the machine on pavement and the other side on forms. 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 a clearance of 1/16 to 1/8-inch between the screed and previously placed pavement.

501.3.5 Texturing.

A. Texture the finished pavement for the entire placement width with an approved tining device. Provide a tining device with flat steel wire tines 3/32-inch 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 from 1/16 to 3/16-inch deep. 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 striping or raised pavement markers. The Department will accept the burlap drag finish for these areas.

B. Pull the tining in the longitudinal direction, parallel to the centerline of the pavement, in 1 pass without dragging or tearing the mortar.

C. Tining too early can pull excessive mortar or aggregate from the pavement. Tining too late could fail to penetrate the surface by the minimum 1/16-inch. The contractor shall decide when to begin tining.

D. Use hand tining devices at least 4-feet wide, equipped with tines identical to those specified above, for areas inaccessible to the mechanical tining device.

E. Immediately follow the tining operation with approved curing.

F. The contractor may elect to diamond grind all surfaces of concrete pavement to create a final texture instead of tining. If the contractor chooses the diamond grinding method, grind only after the concrete obtains a compressive strength of at least 3,500 pounds per square inch. Submit information on similar types of work performed with the proposed grinding equipment, including references if requested by the engineer.

501.3.6 Curing Methods.

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. Apply the first coat immediately following the tining operation and apply the second coat no more than 30-minutes after the first coat.

4. The Department will not allow equipment or traffic, other than joint saws and foot traffic, on the pavement until the compressive strength reaches at least 2,000 pounds per square inch.

B. Polyethylene Sheeting.

1. Place a polyethylene sheeting over the concrete beyond the slab edges by at least twice the pavement thickness. 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 reaches at least 2,000 pounds per square inch. At sawed joint locations, remove as little polyethylene as possible just before the sawing operation. Replace the polyethylene over the sawed joint immediately upon completion of the sawing operation and maintain for the remainder of the curing period.

501.3.7 Quality Control Plan.

Develop and submit a quality control plan in accordance with Section 610.3.A and following the weather limitations in accordance with Section 501.3.8.

501.3.8 Weather Limitations.

A. Cold Weather.

1. Place concrete when the ambient air temperature is at least 35 degrees F and rising.
2. Do not place concrete on frozen grade.
3. Maintain a temperature of not less than 40 degrees F surrounding the concrete pavement for a curing period of 3-days following placement. Provide all necessary monitoring devices such as high-low thermometers or other tools and a plan for monitoring the temperature during the 3-day period. Address use of insulating blankets, straw, polyethylene, or other protection, in the quality control plan.

B. Hot Weather.

1. If plastic concrete temperatures reach 80 degrees F, dampen the subgrade immediately in advance of the concrete placement. Perform finishing, texturing, and curing operations as soon as possible. Suspend paving if the pavement surface dries to the extent that the contractor cannot finish the concrete without application of surface water.
2. The Department will not allow concrete placement when the temperature of the plastic concrete exceeds 90 degrees F.

501.3.9 Joints.

A. Construct in accordance with the Standard Construction Details.

B. Clean and seal all joints with hot-poured sealant material within 5-days after concrete placement in accordance with Section 504, if no overlay is planned.

C. Sawed Joints.

1. Begin joint sawing as soon as the concrete can support the saw and operator with no damage to the pavement surface.
2. Time the sawing so that the concrete does not ravel behind the blade and so that random cracking does not occur.
3. Determine the timing of the saw cutting based on weather, temperature, and contractor judgment. Center the saw cuts over the dowel bars or tie bars. Following saw cutting, provide crack-free pavement except for the cracks under the designed saw cut joints.

D. Construction Joints.

1. Construct this joint at the end of a day’s paving run as submitted in the pre-paving meeting.
2. Before beginning paving operations, provide a formed bulkhead for use in an emergency resulting in 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. Drilling and grouting procedures and related materials must accompany the submission, if applicable. Provide a grout retainer ring if installing dowels by drilling and epoxy grouting.

4. When placing concrete pavement abutting existing concrete, provide a sealant reservoir in accordance with the Standard Construction Details.
5. Construct longitudinal joints directly over tie bars or tie bolts.

501.3.10 Opening the Road to Traffic.
Open the road to traffic when the concrete compressive strength reaches at least 3,500 pounds per square inch.

501.3.11 Performance Measures.

A. The Department will base acceptance and final payment for this item on acceptability of the following:

1. Alignment and Cross-Slope.
   a. Pavement edge within 2-inches of the specified horizontal alignment and a pavement width no less than that specified.
   b. Cross-slope at the specified percent plus or minus 0.5 percent.
2. Consolidation.
   a. Verified by visual observation of pavement edges, pavement cores, and other non- destructive testing as determined by the engineer.
3. Thickness.
   a. Verified by cores.
   b. The Department will adjust payment in accordance with Section 501.5.
4. Ride Quality in accordance with Section 501.5, including pay adjustments.
5. Pavement free of random cracks. Submit repair or replacement procedure to the engineer for approval.
6. Vertical Pavement Edge.
   a. No more than 1/4-inch edge slump, exclusive of rounding of the finishing tool, when measured using a 10-foot straight edge.
7. Dowel Bars.
   a. Located in accordance with the Standard Construction Details.
   b. Verified for contract compliance of locations and alignment using non-destructive testing devices.
8. Tie Bars or Tie Bolts
   a. Located in accordance with the Standard Construction Details.
   b. Verified for contract compliance of locations and alignment using non-destructive testing devices.
9. Concrete.
   a. Meeting the contract compressive strength requirements.
   b. Subject to payment adjustment as outlined in Section 501.5.

501.3.12 Tolerance in Pavement Thickness.

A. For the purpose of establishing an adjusted unit price for pavement lanes, the engineer will:

1. Divide the PCC pavement for the entire contract into 1,000-square yard lots;
2. determine the random core locations;
3. drill the cores;
4. determine pavement thickness according to AASHTO T148; and
5. 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, the Department will consider these irregular lots a complete lot when evaluating the pavement thickness, regardless of the actual size.

C. If a random core measurement is deficient by more than 0.20-inches when compared to the plan pavement thickness, the Department will take 2 additional randomly selected cores within the same lot. The Department will consider cores measuring 0.20-inches or more in excess of the plan pavement thickness to measure exactly 0.20-inches greater than the planned thickness when computing the average of the 3 cores. The Department will consider the average thickness of the 3 cores as the pavement thickness for the lot the Department is evaluating. The Department will use this lot thickness to determine payment for the entire lot in accordance with Table 501.5-1.

D. 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.

501.3.13 Pavement Smoothness.

A. Surface Testing.

Test finished surfaces of concrete pavements, bridge decks, approach slabs, and transition slabs in accordance with the contract using an inertial profiler or 10-foot straight edge. The maximum allowable longitudinal and transverse deviation is 1/4-inch in any 10-feet. Provide a 10-foot straight edge for testing smoothness.

B. Surface Corrections.

Use diamond grinding to remove deviations exceeding 1/4-inch in 10-feet. Submit information on similar types of work performed with the proposed grinding equipment, including references if requested by the engineer.

501.4 Method of Measurement.

A. The Department will measure the quantity as the actual square yards placed. The Department will measure the longitudinal dimension along the centerline of pavement.

B. The Department will not measure areas requiring repairs due to random cracking or failure to meet other performance measures until the contractor makes repairs. In these cases, the Department will withhold the actual repair area quantity from payment.

501.5 Basis of Payment.

A. Payment includes placing, finishing, texturing, and curing concrete pavement meeting the performance measures outlined in Section 501.3.11. The Department will consider the following items incidental to the work and will not pay for the items separately:

1. Repairs to random crack areas;
2. repairs required to meet performance measures;
3. providing a “Thermal Plan” and all accompanying testing equipment;
4. providing smoothness testing results from either an inertial profiling system or a straight edge;
5. performing blanket diamond grinding;
6. sawing, drilling, grouting, sealing, and constructing all pavement joints;
7. sealing sawed joints along the completed pavement edge before placing adjoining pavement;
8. constructing a safety edge;
9. providing cold weather curing materials;
10. providing lighting in accordance with Section 501.3.2.B;
11. providing a template or other approved device for checking dowel bar assembly installation before concrete placement;
12. providing polyethylene sheeting and transverse bulkhead for protecting concrete during a rain event or other emergency;
13. providing and placing dowel bars, tie bars, and their assemblies and support mechanisms and providing verification of their location and alignment using non-destructive testing devices; and
14. installing and preparing lines, wires, tracks or other devices as needed for electronic grade control.

501.5.1 Pavement Thickness Adjustments.

A. For thickness deficiencies, the Department will adjust the contract unit price according to the schedule provided in Table 501.5-1.

Table 501.5-1. 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. The Department will make no additional payment over the contract unit price for any pavement with an average thickness in excess of that shown in the contract. The Department will consider

the plan pavement thickness as the maximum pavement thickness value used in this chart for a 1,000 square yard lot.

501.5.2 Pavement Smoothness Adjustments.
The Department will apply incentive or disincentive pay adjustments as established by this specification and in accordance with the contract.

501.5.3 Low Strength Concrete Adjustments.
The Department will consider concrete that fails to reach full 28-day design strength (f'_c) subject to remedial action. The Department will make prorated payment in accordance with Section 610.5.D. Remove and replace concrete having compressive strength of 500 PSI or more below the designed (f'_c) of the pavement.

ITEM	DESCRIPTION	UNIT
501001	PCC PAVEMENT, 8”	SY
501002	PCC PAVEMENT, 9”	SY
501004	PCC PAVEMENT, 10”	SY
501005	PCC PAVEMENT, 11”	SY
501006	PCC PAVEMENT, 12”	SY
501007	PCC PAVEMENT, 14”	SY

SECTION 503 — PATCHING PORTLAND CEMENT CONCRETE PAVEMENT

503.1 Description.

This work consists of patching existing PCC pavement with high early strength concrete.

503.2 Materials.

A.	PCC, Class A	Section 1022
B.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7
C.	Joint Sealants	Section 1042.1.B
D.	Epoxy Grout	Section 1047.4
E.	Wax-Based Bond Breaker with a Flash Point not less than 200 Degrees F	
F.	Embedded Hardware:	
	1. Tie Bars	Section 1037
	2. Dowel Bars	Section 1073
	3. Tie Bolts – Hook Bolts or W-Bolts	Section 1037

503.3 Construction.

A. Provide a flatwork technician with an ACI or NRMCA certification or a certification from a program pre-approved by the Department to supervise all finishing. Provide the flatwork certification to the engineer before placing concrete.

503.3.1 Patching Limits.

A. The contract or the engineer will designate pavement for patching. The engineer will paint the patching limits on the existing pavement.

B. The Department will designate patches as 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 consisting of dowel support baskets and dowel bars spaced at a maximum of 15-feet.

C. Construct pavement replacement greater than 100-feet in length under Section 501.

D. 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.

E. Submit requests to change patch limits due to poor existing concrete conditions at proposed tie-in locations at least 5-days before removal. The engineer will determine all patching limits

F. Ensure that the patches are at least the depth of the existing slab.

503.3.2 Saw Cutting.

A. Refer to and comply with all requirements listed in Section 762. Construct perimeter cuts plumb and parallel to the roadway centerline. Minimize and seal over-cuts into the remaining slabs as directed by the engineer. Cut existing steel across the patch perimeter. Cut concrete no more than 2-days before removals. Remove and dispose of concrete slurry from saw cutting in accordance

with Section 106.8. Clean all travel lanes to the satisfaction of the engineer before opening to traffic following the saw cutting operation.

503.3.3 Patch Removal.

A. 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. The lift-out technique entails drilling holes into the patch to insert lifting hooks, pins, or chains. Repair damage to the remaining concrete slabs or the base and subgrade caused by improper patch removal using methods approved by the engineer.

B. 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. Remove the existing patch material with minimal disturbance to the remaining concrete or foundation.

C. 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. If the shoulder is not designated for replacement, repair all areas of the shoulder pavement structure removed or disturbed by the patching operation. If the bituminous shoulder is damaged during concrete removal, place a side form to provide a vertical edge for the concrete patch.

503.3.4 Patch Preparation.

A. If the base material appears unsuitable or washed out after removing the concrete, remove the unsuitable material to a maximum depth of 6-inches, or less as directed by the engineer. Fill the excavated area with concrete when placing the patch. Clean out the repair area with hand tools and protect the patch subgrade from water intrusion. Excessive moisture remaining after excavation may require construction of a pipe underdrain system as directed by the engineer or as shown in the contract.

B. In areas of composite pavements consisting of bituminous concrete over PCC pavement, the contractor may pour the concrete patch flush with existing bituminous concrete pavement to eliminate grade differential. Place the additional concrete depth, not to exceed 6-inches, as directed by the engineer.

C. Pay 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 before placing concrete.

D. Just before placing the concrete patch, spray a coating of wax-based bond breaker on the longitudinal and transverse vertical faces of existing concrete pavement adjacent to the patch.

503.3.5 Dowel and Tie Bar Installation.

A. Provide and install dowel support baskets and dowel bars conforming to the requirements of the contract for internal crack control joints at Type B patches. Cut the shipping or tie wires on the dowel bar support basket after placement within the proposed pavement box.

B. Equipment.

Use a drill support system to maintain proper hole alignment. Use gang drills on contracts requiring multiple patches. Saw out all damaged pavement adjacent to the patch if damaged by the drilling operation and replace the damaged sections.

C. Placement.

1. Place dowel bars in accordance with the Standard Construction Details. Tie bars are to be provided and installed for Type B patches that are placed adjacent to concrete. Do not install tie bars on Type A patches.
2. Drill the dowel bar and tie bar holes parallel to the pavement profile and centerline to a depth of half the dowel bar or tie bar length. When using epoxy adhesive, drill holes 1/16-inch greater than the dowel bar or tie bar diameter. When using non-shrink grout, drill hole 1/4-inch greater than the dowel bar or tie bar diameter. Use epoxy adhesive conforming to ASTM C881 Type IV, Grade 2 or 3, Class A, B, and C, or use fast setting non-shrink grout conforming to ASTM C1107. Use compressed air that is dry and oil free at a continuous pressure of at least 100 pounds per square inch, measured at the source, to clean the holes before placing grout or epoxy.
3. 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 bar or tie bar into the grout using a twisting motion to completely coat the dowel bar or tie bar surface. Install a plastic grout retention disk around each dowel bar or tie bar to prevent grout loss and to help center the dowel bar or tie bar in the hole. Support the dowel bars and tie bars in proper alignment until the grout has cured. Align the dowel bars and tie bars not to exceed the tolerances indicated in the contract. Fill any unused hole with epoxy grout.

503.3.6 Placing Concrete.

A. Wet the base course just before placing concrete. The water application rate should not cause any pooling on the grade.

B. Place patching concrete directly on the moist subgrade and uniformly distribute and spread it over the entire patch area. Place the concrete in each patch area in a continuous operation. Consolidate the concrete using a standard spud-type vibrator capable of visibly affecting the concrete a distance of 1-foot from the vibrator head. Insert the vibrator vertically into the concrete without dragging it through the mix.

C. Place the concrete when the ambient air temperature is at least 35 degrees F and rising, unless otherwise allowed by the engineer.

D. Do not place plastic concrete if the temperature reaches 95 degrees F, unless otherwise allowed by the engineer.

503.3.7 Concrete Strength Requirements.

A. 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, within 6-hours of concrete placement. Provide Sure-Cure mold test cylinders and all associated equipment for the engineer's use. The engineer will sample and test the concrete. The engineer may also use the concrete maturity meter, in accordance with AASHTO T325, to determine compressive strength.

B. To accomplish the designed compressive strength in 6-hours, establish the actual combination of weights and proportion of admixtures as required due to field conditions, ambient temperature, humidity, and wind conditions. If unfavorable weather conditions prevent the concrete from reaching the desired strength in 6 hours, reschedule the patching work subject to approval by the engineer. The Department may consider the concrete defective if it fails to meet the compressive strength within 6-hours.

C. Remove and replace concrete the engineer determines to be structurally inadequate. The Department will allow concrete determined to be structurally adequate by the engineer, but not

meeting 2,000 pounds per square inch in 6-hours, to remain in place at a prorated payment in accordance with Section 503.5.1. If the contractor does not want to accept the prorated payment, the contractor may remove and replace the concrete in an attempt to achieve full compensation.

503.3.8 Finishing Concrete.

A. 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 contractor may place the screed perpendicular to the centerline of the roadway.

B. Provide a tined finish on the concrete patch with the texture applied in a direction perpendicular to the traffic flow when a bituminous concrete overly will cover the patch surface. Match the adjacent pavement surface cross slope and profile. The Department will consider the patch unacceptable if the profile in the finished patch area contains excessive surface deviations. The maximum allowable longitudinal and transverse deviation is 1/4-inch in 10-feet. Provide a 10-foot straight edge for testing. When the concrete patch is the final roadway surface, match the texture of the adjacent pavement. Match the patch surface cross section with the preceding and following pavement surfaces. The Department will not allow use of steel trowels for finishing surfaces. The engineer may test for excessive surface deviations with a straightedge, a profilometer, or other surface measuring device.

C. Repair damaged concrete or the bituminous shoulder before opening the patch area to traffic.

503.3.9 Curing.

A. Use one of the methods listed below:

1. White Membrane Curing Compound

   a. Spray the curing material on the pavement surface and all exposed edges immediately following concrete texturing.

   b. Continuously agitate the curing material during application to keep it thoroughly mixed.

2. Polyethylene Sheeting

   Place polyethylene sheeting over the concrete and beyond the slab edges a distance that equals double the pavement thickness. Add weight to secure the material against wind and weather.

3. Insulating Blankets

   Secure edges and seams of insulating blankets to prevent dislodging due to wind, rain, or adjoining traffic. Use insulating blankets in accordance with Section 610.3.5.C.6.

503.3.10 Joints.

A. Install in accordance with the Standard Construction Details.

B. Clean and seal all joints with hot-poured sealant material after the specified strength has been achieved, if no overlay is planned in accordance with Section 504.

C. Form or saw transverse and longitudinal joints as shown in the contract. Saw transverse joints in Type B patches matching existing within the patch area in accordance with Section 501.3.9. Clean and seal the joints around the entire patch perimeter, and all transverse joints in larger patches, with hot-poured sealant material within 5 days after concrete placement, if no overlay is planned. Refer to and comply with all Section 504 requirements.

D. If the pavement will receive an overlay, the contractor may tool the transverse joints at the ends of the patch. The Department will not require a sealant reservoir in this case. Widen and seal the sawed transverse joints for crack control within Type B patches for both finished surface and overlay conditions.

503.3.11 Performance Measures.

Repair or remove and replace uncontrolled random cracks before Final Acceptance and payment. Submit repair or replacement procedures to the engineer for approval.

503.4 Method of Measurement.

A. Patching PCC Pavement, 6 feet to 15 feet, Type A and Patching PCC Pavement Greater than 15 feet to 100 feet, Type B.

1. The Department will measure concrete patches placed and accepted by the square yard. The Department will measure the width from outside of the completed patches as constructed and will measure parallel to the transverse saw cuts. The Department will measure parallel to the centerline of the pavement, along the center of the patch. The Department will not measure additional patch areas made necessary due to improper concrete removal or saw cutting.

B. Undercut Excavation, Patching.

1. The Department will measure material removed below the bottom of the original concrete pavement the contractor patched by the cubic yard. Refer to Section 202.3.7.

C. Patching Concrete.

1. The Department will measure concrete placed in undercut areas below the bottom of the original pavement requiring the patch, or additional thickness above in order to eliminate grade differential in finished pavements by the square yard-inch.

D. Saw Cutting.

1. Refer to Section 762 for the method of measurement.

E. Dowel Bars.

1. The Department will measure the dowel bars installed and accepted at the ends of a patch as each. The Department will not measure dowel bars and dowel support baskets (load transfer assemblies) installed at internal crack control joints in Type B patches. The Department will consider dowel bars and dowel support baskets installed at internal crack control joints in Type B patches as incidental to the contract unit price per square yard for item 503002 – Patching PCC Pavement, Greater Than 15 feet to 100 feet, Type B.

F. Crack and Joint Sealing Less than 3/4-Inch Wide.

1. Refer to Section 504 for crack and joint sealing methods of measurement.

G. Tie Bars.

1. The Department will not measure tie bars placed in Type B patches.
2. Do not place tie bars in Type A patches.

503.5 Basis of Payment.

A. If the contract calls for replacing a bituminous overlay, the Department will pay for the overlay using the applicable bituminous concrete pay item.

B. Type A Patches.

1. Square yard payment will constitute full compensation for:

   a. Providing, placing, finishing, texturing, and curing concrete;

   b. Sure-Cure test molds and curing materials;

   c. removing and disposing of existing concrete and any bituminous overlay remaining on the patch area at the time of removal;

   d. preparing the foundation;

   e. tooling, finishing, curing, texturing, sealing of over-cuts in non-overlay areas, and protecting the new concrete; and

   f. disposing of excess material resulting from necessary undercutting.

2. Type B Patches.

   a. The square yard payment includes everything listed under basis of payment for Type A patches and the following:

      i. Providing and installing load transfer assemblies consisting of dowel bars and dowel support baskets at all transverse joint locations except at either end of the patch;

      ii. providing and installing tie bars in accordance with the Standard Construction Details; and

      iii. transverse saw cutting and sealing in accordance with the Standard Construction Details.

C. Undercut Excavation, Patching.

1. The Department will pay this item separately in accordance with Section 202.3.7.

D. Patching Concrete.

1. The square yard-inch payment includes providing and placing concrete to depths not to exceed 6-inches resulting from the undercut excavation, patching item, or to eliminate the grade differential of finished pavements.

E. Saw Cutting Concrete, Full Depth.

1. The Department will pay this item separately in accordance with Section 762.

2. The Department will consider the following as incidental to the item of work and will make no separate payment for this work:

   a. Cutting existing bituminous overlays up to 8-inches thick over the concrete unless otherwise noted in the contract;

   b. cutting existing steel across the patch perimeter; and

   c. additional cuts to facilitate patch removal.

F. Dowel Bars.

1. Payment for each dowel bar includes:

   a. Drilling the dowel holes;

b. providing and placing dowel bars;

c. anchoring grout;

d. grouting retainer disks; and

e. providing and placing temporary dowel supports to maintain alignment.

G. Crack and Joint Sealing Less Than 3/4-Inch Wide.

1. The Department will pay for this item separately in accordance with Section 504.

503.5.1 Price Adjustment for Low Strength Concrete.
The Department will calculate the prorated payment for concrete, as referenced in Section 503.3.7, 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 PCC PAVEMENT, 6’ TO 15’, TYPE A	SY
503002	PATCHING PCC PAVEMENT, 15’ TO 100’, TYPE B	SY
503004	PATCHING PCC PAVEMENT (UNDERCUTTING)	SY-IN
503006	DOWEL BARS	EA

SECTION 504 — PCC CRACK AND JOINT SEALING

504.1 Description.

This work consists of sealing existing transverse joints, longitudinal joints, and pavement cracks in existing pavement, existing patches, or around new patch perimeters.

504.2 Materials.

A.	Crack Sealant	Section 1042.1.A
B.	Joint Sealant	Section 1042.1.B

504.3 Construction.

504.3.1 Sealant Equipment.
Use sealing equipment specifically recommended by the sealant manufacturer.

504.3.2 Existing Sealant Removal.

A. Remove sealant from existing joints using a vertical cutting-edge tool or a power-driven high-pressure water blaster. The Department will not allow use of V-shaped plow tools to remove existing sealant.

B. Remove the existing sealant to the depth required to accommodate hot pour sealant in accordance with the Standard Construction Details.

504.3.3 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, to expose new clean PCC, or to cut the joint to the width and depth necessary to provide the joint reservoirs shown in the contract.

504.3.4 Cleaning Before Resealing.

A. Following sawing, re-sawing, or refacing operations on newly constructed or existing joints, clean the joint faces and openings by sandblasting, followed by compressed air that is dry and oil free. Use compressed air equipment that delivers a continuous pressure of at least 100 pounds per square inch, measured at the source, to remove cuttings or debris remaining on the joint faces or in the joint openings.

B. Ensure that the PCC joint surface receiving the new joint sealant is free of:

1. Tar and asphalt;
2. old sealant;
3. discoloration and stain; and
4. other contamination of the concrete structure that would not result in a clean, dry, newly exposed concrete surface.

C. When the bottom of the joint opening the contractor plans to seal is formed by previously installed expansion joint material, such as at existing concrete patch locations, insert a nonreactive adhesive-backed tape instead of the backer rod. Place tape 1/8-inch wider than the nominal joint width.

D. Equip air compressors with traps capable of removing moisture and oil from the compressed air. Stop work when there is oil or moisture in the compressed air. Make necessary adjustments to the equipment until the air stream is free of contaminants before resuming work.

E. The Department will not allow placement of sealant if dust, moisture, oil, or other contaminants are present on the concrete surface.

F. Protect the public from hazard or damage during the sandblasting and joint cleaning operations by shielding the work with rigidly supported plywood sheeting or other suitable material and methods subject to the engineer's approval.

G. Take care not to damage the subbase, curbs, shoulders, load transfer devices, or pavement. If damage occurs, submit repair procedure for approval and perform repairs to the satisfaction of the engineer.

504.3.5 Limits of Joint Preparation.

Limit the final stages of joint preparation, including air pressure cleaning of joints, and placement of separating or backup material, to the length of joint that will be resealed during a day's production.

504.3.6 Installation of Hot-Poured Sealant.

A. Follow the manufacturer's recommendations for heating and applying the sealant. Provide a copy of the manufacturer's recommendations to the engineer.

B. Discard and dispose of the first gallon of material to flow out of the applicator wand at the beginning of the day.

C. 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 1/16 to 3/16-inch below the adjacent pavement surface. Remove excess material on the surface of the pavement. Do not allow traffic on the pavement in the area of the joints during the curing period.

D. Submit repair procedure for failed joints to the engineer for approval.

504.4 Method of Measurement.

A. The Department will measure the linear footage along the crack or joint from end to end.

B. The Department will not measure sealed overcuts and will consider these areas as incidental to the saw cutting item.

504.5 Basis of Payment.

A. The Department will pay for the accepted quantity of crack and joint sealing at the contract unit price per linear foot. Payment constitutes full compensation for:

1. Providing and placing hot-poured joint sealer;
2. removal and disposal of existing joint sealer;
3. joint re-sawing and refacing;
4. sandblast cleaning; and
5. air-blast cleaning.

ITEM	DESCRIPTION	UNIT
504001	PCC CRACK AND JOINT SEALING LESS THAN 3/4-INCH WIDE	LF
504002	PCC CRACK AND JOINT SEALING, 3/4-INCH TO 1 3/4-INCH WIDE	LF

SECTION 505 — PCC PATCHING, PARTIAL DEPTH

505.1 Description.

This work consists of partial depth patching of PCC.

505.2 Materials.

A. PCC Patching Material, Partial Depth — Sections 1022 and 1023

B. Joint Sealants — Section 1042.1.2.B

C. Wax-Based Bond Breaker with a Flash Point not less than 200 degrees F

505.3 Construction.

Provide a flatwork technician with an ACI or NRMCA certification, or a certification from another program pre-approved by the Department, to supervise all concrete finishing work. Provide the flatwork certification to the engineer before placing concrete.

505.3.1 Preparation and Placement.

A. Saw cut to depth in accordance with the Standard Construction Details 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 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.

B. If a partial depth repair area abuts a working joint or crack that penetrates the full depth of the slab, place an insert, styrofoam, wax-based bond breaker or other approved bond-breaking medium to maintain existing joint dimensions.

C. Air-blast clean the patch surface of the prepared concrete just before placement of the patch material.

505.3.2 Joints.

A. Ensure that joints in the existing concrete pavement remain transversely and longitudinally unobstructed.

B. Install joints in accordance with the Standard Construction Details.

C. Clean and seal all joints with hot-poured sealant material after the specified strength has been achieved, if no overlay is planned in accordance with Section 504.

505.3.3 Concrete Strength Requirements.

A. In addition to the requirements in Section 503.3.7 and ASTM C-109, mix, place, and cure the patch material in accordance with the manufacturer's recommendations. The contractor may open the patch area to traffic once the patch material reaches a compressive strength equal to or greater than 2,000-psi. Use only rapid cured concrete that will reach a compressive strength of 2,000-psi in 6-hours or less.

B. If unfavorable ambient temperature is predicted that would prevent achieving the desired strength in the desired timeframe, then reschedule the work, subject to the approval of the engineer.

505.4 Method of Measurement.

The Department will consider the quantity placed and accepted, as measured in the field by the square yard and multiplied by the depth in inches, as the measurement.

505.5 Basis of Payment.

A. The Department will pay for the accepted quantity of PCC patching at the contract unit price per square yard per inch. Payment constitutes full compensation for:

1. Saw cutting;
2. removing existing deteriorated concrete;
3. cleaning and preparing the patch area;
4. forming and maintaining existing pavement joints;
5. providing, placing, and curing patch material; and
6. providing and placing hot-poured joint sealer.

B. The Department will not pay for patch areas constructed outside the limits marked in the field or outside the limits approved by the engineer.

C. The Department will consider joint sawing, sealing, and maintenance of existing joints incidental to this item and will make no separate payment for this work.

ITEM	DESCRIPTION	UNIT
505000	PCC PATCHING, PARTIAL DEPTH	SY-IN

DIVISION 600 — STRUCTURES

SECTION 601 — PIPE CULVERTS

601.1 Description.

This work consists of providing and placing pipe culverts, flared end sections, and connections to existing drainage inlets and manholes.

601.2 Materials.

A.	Reinforced Concrete Pipe	Section 1031
B.	Thermoplastic Pipe	Section 1031
C.	Flared End Section	Section 1031
D.	GABC	Section 1005
E.	PCC, Class A, B, or C	Section 1022
F.	Chemical Sealing	Section 1047.5
G.	Mortar	Section 1047.6
H.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7

601.3 Construction.

601.3.1 Preconstruction Inspection.

The Department will review all existing pipes for use in the final drainage system and will discuss the system condition with the contractor before starting construction.

601.3.2 Excavation and Pipe Bedding.

A. Excavate the pipe trench and place bedding within the template of the item in accordance with Section 207 and the Standard Construction Details. Class C bedding is to be used in accordance with the Standard Construction Details unless specified otherwise. When Class A bedding is specified, cure PCC with materials in accordance with Section 1022.6. Remove unsuitable material encountered below the proposed pipe bedding and replace as directed by the engineer in accordance with Section 207.

B. When the contract calls for placing pipe in an embankment or fill area that has not been fully constructed, create a fill area for the pipe a minimum width of 2 pipe diameters on each side of the pipe and 18-inches over the top of the pipe. If the embankment finished elevation is less than 18-inches above the pipe, build the fill to the finished elevation. Once the fill area is created, trench for pipe placement.

601.3.3 Reinforced Concrete Pipe.

A. Joints

1. Before laying the pipe in the trench, attach the rubber gasket or joint sealant to the spigot end of each pipe as follows:

a. For bell and spigot pipe, use a rubber gasket in accordance with ASTM C443. Place the rubber gasket around the entire circumference of the spigot and set firmly against the offset step. Before installation, apply a lubricant specified by the gasket manufacturer.

b. For pipe manufactured with tongue and groove joints, use performed flexible bitumen or butyl joint sealant in accordance with ASTM C990. Apply the sealant around the entire circumference of the pipe tongue in a position that will ensure compression against the opposing pipe groove. Follow the sealant manufacturer's recommendations when applying the sealant.

2. Control pipe handling, after affixing the gasket, to avoid bumping, displacing, or fouling the gasket with dirt or other material. Remove disturbed gaskets and reposition if displaced or replace if damaged. Apply sufficient pressure when making the joint to ensure that the joint is tight.

B. Placing pipe

Lay pipe in an upgrade direction in accordance with the contract and the requirements of ASTM C1479. Lay the pipe with the lowest point of the inside diameter conforming to the flow line shown in the contract. Lay pipe with the bell ends facing up grade and with the spigot ends fully entered into each bell end.

C. Defects

1. The engineer will reject pipe pre-installation for any of the following reasons:

a. An illegible brand;

b. spalls; and

c. cracks greater than 0.01-inch in width extending 12-inches or greater regardless of position in the pipe wall or is continuous through the wall of the pipe and in accordance with AASHTO M207 or M170.

2. The engineer will determine the need for remediation or replacement for pipe post-installation for any of the following reasons:

a. Vertical or horizontal misalignment;

b. spalls;

c. slabbing meaning large slabs of concrete peeling away from the sides with a straightening of the reinforcement;

d. cracks greater than 0.01-inch in width extending 12-inches or greater regardless of position;

e. cracks greater than 0.1-inch in width and in accordance with AASHTO M207 or M170;

f. differential joint movement;

g. improper gasket or joint sealant placement;

h. joint leakage;

i. settlement; and

j. joint separations greater than manufacturer's recommendation or as follows, whichever is less:

i. 12 to 36 inch diameter 0.75 inch

ii. 42 inch and larger diameter 1.25 inch

iii. All elliptical pipe 1.50 inch

601.3.4 Thermoplastic Pipe.

A. Joints.

1. For type S pipes, use gasketed watertight bell and spigot in accordance with ASTM D3212.
2. For type C pipe, use bell and spigot joints in accordance with ASTM D3212. For split-collar couplings, engage at least 2 full corrugations on each pipe section. Use screw-on collars at least 1/2 the nominal diameter of the pipe wide.

B. Placing pipe.

Lay pipe in an upgrade direction in accordance with the contract and the requirements of ASTM D2321. Lay the pipe with the lowest point of the inside diameter conforming to the flow line shown in the contract. Lay the pipe with the bell ends facing upgrade and with the spigot ends fully entered into each bell end.

C. Defects.

1. The engineer will reject pipe pre-installation for any of the following reasons:
   a. Illegible brand;
   b. unpigmented or non-uniformly pigmented pipe; and
   c. cracking or tearing.
2. The engineer will determine remedial or replacement for pipe post-installation for any of the following reasons:
   a. pipe deflection greater than 5 percent or the manufacturer's recommendation, whichever is less;
   b. vertical or horizontal joint misalignment;
   c. connections with a gap exceeding 3/16-inch;
   d. cracking or tearing;
   e. creases; and
   f. joint separations greater than the manufacturer's recommendation or 1-inch, whichever is less.

601.3.5 Flared End Section.

A. Excavate within the template of the item in accordance with Section 207 and the Standard Construction Details.

B. Remove unsuitable material when encountered and replace with approved material.

C. Compact the foundation.

D. Place GABC to the required thickness in accordance with Section 301.

E. Pour concrete cutoff wall in accordance with the Standard Construction Details and cure PCC with materials in accordance with Section 1022.6.

F. Install flared end sections in accordance with Sections 601.3.2, 601.3.3, or the manufacturer's recommendations.

601.3.6 Backfill.

A. Backfill pipe in accordance with Section 207. Where heavy construction equipment will travel over the pipe, place a minimum of 4-feet of cover over the pipe. When placing multiple pipes side by side, provide a minimum of 18-inches between the pipes.

B. Use existing material for backfill if it meets the requirements of Section 1001, Borrow Type C. If existing material does not meet the requirements of Section 1001, Borrow Type C, provide Borrow Type C in accordance with Section 207. Compact the material to a minimum of 95 percent of the maximum density, in accordance with Section 202.3.9. Backfill pipe 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 in accordance with the contract. Use existing material for backfill above the 12-inches if it meets the requirements of Section 1001, Borrow Type F. If existing material does not meet requirements of Section 1001, Borrow Type F, provide Borrow Type F in accordance with Section 209.

C. Place an initial backfill lift no more than 8-inches thick of loose material and no higher than the spring line of the pipe. Ensure that backfill material fills the space under the haunches of the pipe by knifing with a shovel or blade. Place a maximum of 8-inches of loose material for each of the following lifts.

D. When specified by the contract, use flowable backfill material.

1. Provide a trench that measures 6-inches from the trench wall to outside wall of the pipe on both sides of the pipe. When placing multiple pipes side by side, provide a minimum of 6-inches between the pipes.

2. Place flowable fill equally to both sides of the pipe. Ensure that the fill on 1 side of the pipe does not exceed the height of the fill on the other side by more than 12-inches.

601.3.7 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. Remove and dispose of material removed during the pipe cleaning operation at a site approved by the engineer in accordance with Section 106.8.

C. Clean all new pipe culverts and all existing pipe culverts as designated in the contract without damaging the pipe, pipe joints, or connecting structures by flushing with high pressure water. Using equipment that complies with the manufacturer's recommendations for the pipe size, expose all inside surfaces and joints to the satisfaction of the engineer. If these methods do not adequately clean the pipe after 3 passes, the engineer may direct the contractor to use other procedures covered by heavy pipe cleaning or other items of work.

1. New pipe culvert shall be cleaned prior to post installation inspection. Provide adequate cleaning that allows for an unobstructed view of all joints and for accurate defect measurement.

2. Clean existing pipe culverts designated to be cleaned to the satisfaction of the engineer.

D. Heavy Pipe Cleaning.

Submit methods for heavy pipe cleaning to the engineer for approval before beginning work.

601.3.8 Post Installation Inspection.

A. The Department will video, deflection test, or manually inspect repaired, lined, or new pipes 48-inches in diameter or less no sooner than 30-days after placement or before placement of the final lift of hot mix.

B. The Department will manually inspect pipes 48-inches in diameter or larger.

C. Clean pipe before video or manual inspection.

D. Provide traffic control during pipe inspection as needed.

E. The Department will conduct inspections of pipes placed under paved areas, or areas planned for paving, before placement of the final layer of roadway pavement material.

F. Defects determined by the engineer to require remedial work will require submittal and approval of the repair.

601.3.9 Personnel Safety Grate for Pipe Inlet

A. Prepare and submit working drawings in accordance with Section 105.4.

B. Construct personnel safety grates for pipe inlets in accordance with the Standard Construction Details.

601.4 Method of Measurement.

A. The Department will measure:

1. Pipe culverts as linear feet for each type of pipe placed and accepted, measured from end to end. The measurement will include the portion of the pipe in the structure wall to the inside face of the structure. The Department will not consider the linear footage of pipe to include beyond the inside face of the structure wall nor flared end sections.
2. Flared end sections as each accepted and placed.
3. Cleaning of existing drainage pipe as linear feet cleaned and accepted, measured from end to end.
4. Heavy pipe cleaning as the number of hours the contractor actively engages in heavy pipe cleaning work.
5. Personnel safety grate for pipe inlet as the number of each installed and accepted.

601.5 Basis of Payment.

A. The Department will pay the quantity of:

1. Pipe culverts at the contract unit price per linear foot. Price and payment will constitute full compensation for:
   a. Shoring;
   b. removal and disposal of existing materials;
   c. bedding preparations;

d. Supplying, placing, and curing PCC;

e. providing and placing materials;

f. compaction;

g. forms and forming;

h. placing bedding;

i. removing surplus materials;

j. cleaning in accordance with Section 601.3.7 and maintenance of traffic to support the pipe video inspection; and

k. removing and replacing damaged pipe.

2. Flared end sections at the contract unit price per each. Price and payment will constitute full compensation for:

a. Shoring;

b. removal and disposal of existing materials;

c. bedding and foundation preparation;

d. providing and placing materials;

e. compaction;

f. forms and forming;

g. supplying, placing, finishing, and curing PCC;

h. mortar;

i. removing surplus materials; and

j. removing and replacing damaged pipe.

3. Pipe cleaned at the contract unit price per linear foot. Price and payment will constitute full compensation for providing equipment and water, cleaning the pipe, and disposing of removed material.

4. Heavy pipe cleaning at the contract unit price per hour. Price and payment will constitute full compensation for providing equipment and water, cleaning the pipe, and disposing of removed material.

5. Personnel safety grate for pipe inlet at the contract unit price per each. Price and payment constitute full compensation for:

a. preparing submittals and working drawings;

b. providing and placing all materials;

c. fabricating;

d. disposal;

e. pad lock;

f. bar reinforcement; and

g. coatings.

B. The Department will pay for:

1. Excavation and embankment outside the template of the item in accordance with Section 202 at the direction of the engineer or contract.
2. Pipe backfilling in accordance with Section 207.
3. Pipe excavation in accordance with Section 207.
4. Extra depth excavation in accordance with Section 207.
5. Providing structural backfill in accordance with Section 207.
6. Providing flowable fill in accordance with Section 208.
7. Providing borrow in accordance with Section 209.

ITEM	DESCRIPTION	UNIT
601000	CLEANING DRAINAGE PIPE, 12"-24" DIAMETER	LF
601001	CLEANING DRAINAGE PIPE, GREATER THAN 24" DIAMETER	LF
601002	HEAVY CLEANING OF DRAINAGE PIPE	HOUR
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

ITEM	DESCRIPTION	UNIT
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

ITEM	DESCRIPTION	UNIT
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

ITEM	DESCRIPTION	UNIT
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

ITEM	DESCRIPTION	UNIT
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
601023	CORRUGATED POLYETHYLENE PIPE, TYPE S, 21"	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
601270	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 12"	LF
601271	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 15"	LF
601272	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 18"	LF
601274	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 24"	LF
601275	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 30"	LF

ITEM	DESCRIPTION	UNIT
601276	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 36"	LF
601277	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 42"	LF
601278	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 48"	LF
601279	CORRUGATED POLYPROPYLENE PIPE, TYPE S, 60"	LF
601280	PERSONNEL SAFETY GRATE FOR PIPE INLET	EACH

SECTION 602 — DRAINAGE STRUCTURES

602.1 Description.

This work consists of constructing, providing, replacing, adjusting, and repairing drainage inlets, drainage inlet frames and grates, manholes, manhole frames and covers, and junction boxes.

602.2 Materials.

A.	GABC	Section 1005
B.	PCC, Class A or B	Section 1022
C.	Expansion Joint Material	Section 1042.2.A
D.	Bar Reinforcement	Section 611 and Section 1037
E.	Liquid Membrane-Forming Compounds for Curing	Section 1022
F.	Welding	AASHTO / AWS D1.1 Welding Code
G.	Castings	Section 1039.7
H.	Steps	AASHTO M199 and ASTM C478
I.	Borrow, Type C	Section 1001
J.	Rectangular Precast Structures	ASTM C913
K.	Round Precast Structures	AASHTO M199
L.	Joint Sealant	Section 1042.2.B
M.	Non-Shrink Grout	Section 1047.2
N.	Mortar	Section 1047.6
O.	Silane-Based Concrete Sealer	Section 1045.3
P.	Precast Flexible Joint Sealant	Section 1042.5

602.3 Construction.

A. Shop Drawings

1. Submit shop drawings that include quantities and locations for installations not meeting Standard Construction Details before fabrication for:
   a. Drainage inlets, manholes, and junction boxes. Include design calculations ensuring the proposed structure can handle all loads including the HS-20 live load.
   b. Drainage inlet frames and grates, and manhole frames and covers.
   c. Drainage inlet frames, manhole frames, and junction boxes that require adjustments or repair.
2. For locations that require repair, adjustments, or replacement, include field measurements to determine the exact sizes of the drainage inlet frames and grates, and manhole frames and covers before placing the order.

3. For locations that require the repair of existing junction boxes, include field measurements to determine the exact sizes of the 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 capable of meeting or exceeding HS-25 load rating requirements in accordance with AASHTO M306.
5. Use PCC, Class A for drainage inlets, manholes, and junction boxes that do not conform to the requirements of the Standard Construction Details;

B. Constructing Drainage Inlets, Manholes, and Junction Boxes

1. Refer to shop drawings, contract documents, or Standard Construction Details for dimension and structure requirements.
2. Excavate and backfill in accordance with Section 207.3. Compact the structure foundation to a firm, even surface, to the acceptance of the engineer.
3. Use cast-in-place construction for drainage structures that tie into existing pipes and structures unless otherwise specified in the contract. The contractor may request use of precast structures subject to the engineer's approval. Use precast structures for new construction unless otherwise specified in the contract.
4. Construct cast-in-place reinforced concrete structures in accordance with Section 610.
5. Construct precast reinforced concrete structures in accordance with Section 612.
6. Provide precast reinforced concrete round manhole riser sections and appurtenances in accordance with AASHTO M199.
7. Set the frames of castings in concrete.
8. For drainage inlets, manholes, and junction boxes that use a removable top slab or are 4-feet or deeper when measured from the top of grate or cover to the invert of the lowest pipe, install steps at an accessible location. Ensure that the steps have a minimum embedment of 3-inches into the wall and protrude out 6 inches from the wall. Begin steps within 24-inches of the top of grate or lid and place the last step no more than 12-inches above the lowest invert except where a pipe is in the same wall as the steps in which case the last step must be placed such that the last step is no more than 12-inches from the top of the pipe. Place steps vertically 12-inches apart.
9. Ensure inlet and outlet pipes are the same size and type as the connecting pipes shown in the contract and that pipes extend through, and are flush with, the inside of the wall. When cutting off the end of a reinforced concrete pipe, finish with mortar so that no reinforcement steel 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 5,000-PSI. Ensure that the pipe opening in the drainage inlet is no more than 4-inches larger than the pipe diameter measured from the outside wall of the pipe.
10. Construct, finish, and cure cast-in-place structures other than top units in accordance with Section 610.3.6.
11. Construct, finish, and cure the structure top units in accordance with Sections 501.3 or 503.3.
12. Pour the flow channel to provide positive flow. Cure the flow channel with materials in accordance with Section 1022.6 except water curing will not be permitted.

13. Backfill the area around drainage inlets and manholes with Borrow Type C material in accordance with Section 207.

14. Prepare surface exposed concrete ahead of sealing in accordance with Section 613.3.B. Seal surface exposed concrete with silane sealer meeting the requirements of Section 1045.3 in accordance with Section 613.3.D.

C. Remove existing and provide new grates and frames for repair and adjustments of drainage Inlets, manholes and junction boxes.

D. Adjusting and Repairing Drainage Inlets, Manholes, and Junction Boxes.

1. Adjusting.

a. Supply and install solid adjustment ring in accordance with the utility owner's recommendation.

b. Adjust with top unit in accordance with the Standard Construction Details as follows:

i. Saw cut existing bituminous concrete or PCC pavement for top unit installation in accordance with the Standard Construction Details.

ii. Excavate materials from the perimeter in accordance with Section 207.3. Dispose of waste materials in accordance with Section 106.8.

iii. Remove existing castings. Clean and set castings aside for reuse or replacement in accordance with the contract. If the engineer determines that the casting is damaged and not suitable for reuse, provide a new casting in accordance with Section 602.3.B

iv. Place forms for the top unit to accommodate the replacement frame.

v. Do not place the frame on bricks, blocks, or other materials.

vi. Place required steel reinforcement and encase in PCC, Class B. Cure in accordance with Sections 501.3 or 503.3.

vii. Prepare surface exposed concrete ahead of sealing in accordance with Section 613.3.B. Seal surface exposed concrete with a silane sealer meeting the requirements of Section 1045.3 in accordance with Section 613.3.D

viii. Take removed drainage inlet frames, grates, manhole frames, and covers, to the Department's District Maintenance Yard or to a location specified in the contract.

ix. Seal joints in accordance with Section 504.

2. Repairing.

a. Remove covers of drainage inlets or manholes for inspection by the engineer.

b. If the engineer determines the structure is in good condition, adjust the castings according to Section 602.3.D.

c. If the engineer determines the existing structure is in poor condition, repair as directed by the engineer.

d. Backfill the area around drainage inlets and manholes with Borrow Type C material in accordance with Section 207.

e. Backfill the area around drainage inlets and manholes with GABC in accordance with Section 301.

f. Install steps in an accessible location in drainage inlets or manholes as needed in accordance with Section 602.3.B.8.

g. If a new flow channel is needed, ensure positive flow when constructing the channel.

3. Connect pipes to drainage inlets, manholes, and junction boxes in accordance with Section 602.3.B.9 and as directed by the engineer.

602.4 Method of Measurement.

A. The Department will measure the quantity of drainage inlets, manholes, and junction boxes as the number of each installed and accepted. The Department will measure inlet and outlet pipes with the adjoining pipe. The Department will not measure frames and grates and will consider these items as included in the drainage inlet, manhole, or junction box items.

B. The Department will measure the quantity of provided drainage inlets and manholes grates and frames as the number of each placed and accepted.

C. The Department will measure the quantity of adjusted and repaired existing drainage inlets, manholes, and junction boxes as the number of each adjusted or repaired and accepted.

D. The Department will measure the quantity of special drainage inlets, special junction boxes, and special manholes placed as the number of each.

E. The Department will not measure the quantity of special drainage inlets, special junction boxes, and special manholes placed and accepted measured as lump sum.

F. The Department defines the template as 24-inches outside the neat-line perimeter of drainage inlets, manholes, and junction boxes.

602.5 Basis of Payment.

A. The Department will pay the quantity of the drainage inlet, special drainage inlets, manholes, and junction boxes at the contract unit price. Price and payment will constitute full compensation for:

1. Excavating within the template of the item;
2. removal and disposal of existing materials;
3. foundation preparation and compaction;
4. providing and placing materials;
5. forms and forming;
6. supplying, placing, finishing, curing, and sealing PCC;
7. joints;
8. backfilling;
9. removing surplus materials; and
10. removing and replacing cracked or damaged drainage inlets, special drainage inlets, manholes, and junction boxes.

B. The Department will pay the quantity of grates and frames at the contract unit price of each. Price and payment will constitute full compensation for supply, replacement, and disposal of the existing materials.

C. The Department will pay the quantity of adjusted and repaired existing drainage inlets, manholes, and junction boxes at the contract unit price of each. Price and payment will constitute full compensation for:

1. Sawcutting;
2. excavating within the template of the item;
3. removal and disposal of existing materials;
4. foundation preparation and compaction;
5. providing and placing materials;
6. forms and forming;
7. supplying, placing, finishing, curing, and sealing PCC;
8. joints;
9. expansion joint material;
10. sealing;
11. backfilling;
12. removing surplus materials; and
13. removing and replacing cracked or damaged drainage inlets, manholes, and junction boxes.

D. The Department will pay for adjust and repair to the depth of the adjustment as follows:

1. The contract unit price for units repaired from the top of the unit frame to a depth 3-feet below the frame.
2. One and a half times the contract unit price for units repaired to a depth ranging from 3-feet below the frame to 4 1/2-feet below the frame.
3. Double the contract unit price for units repaired more than 4 1/2-feet below the frame.
4. Work to adjust or repair flow channels is excluded from depth of repair payment adjustments.

E. The Department will pay for bituminous pavement patching in accordance with Section 401.

F. Submit the breakout sheet included in the proposal for lump sum items in accordance with Section 109.

ITEM	DESCRIPTION	UNIT
602000	DRAINAGE INLET, 17.625” X 11.625”	EACH
602001	DRAINAGE INLET, 24” X 24”	EACH
602002	DRAINAGE INLET, 34” X 18”	EACH
602003	DRAINAGE INLET, 34” X 24”	EACH
602004	DRAINAGE INLET, 48” X 30”	EACH

602005	DRAINAGE INLET, 48” X 48”	EACH
602006	DRAINAGE INLET, 66” X 30”	EACH
602007	DRAINAGE INLET, 66” X 48”	EACH
602008	DRAINAGE INLET, 66” X 48”	EACH
602009	DRAINAGE INLET, 72” X 24”	EACH
602010	DRAINAGE INLET, 72” X 48”	EACH
602011	DRAINAGE INLET, 72” X 72”	EACH
602012	DRAINAGE INLET, SPECIAL	EACH
602013	DRAINAGE INLET, SPECIAL	LS
602030	MANHOLE, 48” X 30”	EACH
602031	MANHOLE, 48” X 48”	EACH
602032	MANHOLE, 66” X 30”	EACH
602033	MANHOLE, 66” X 48”	EACH
602034	MANHOLE, 66” X 66”	EACH
602035	MANHOLE, ROUND	EACH
602036	MANHOLE, SPECIAL	EACH
602037	MANHOLE, SPECIAL	LS
602060	JUNCTION BOX, 48” X 30”	EACH
602061	JUNCTION BOX, 48” X 48”	EACH
602062	JUNCTION BOX, 66” X 30”	EACH
602063	JUNCTION BOX, 66” X 48”	EACH
602064	JUNCTION BOX, 66” X 66”	EACH
602065	JUNCTION BOX, SPECIAL	EACH
602066	JUNCTION BOX, SPECIAL	LS
602067	CONVERTING DRAINAGE INLET TO JUNCTION BOX	EACH
602100	DRAINAGE INLET GRATE(S)	EACH
602101	DRAINAGE INLET FRAME(S)	EACH
602102	MANHOLE GRATE(S)	EACH
602103	MANHOLE FRAME(S)	EACH
602130	ADJUSTING AND REPAIRING EXISTING DRAINAGE INLET	EACH
602131	ADJUSTING AND REPAIRING EXISTING DOUBLE DRAINAGE	EACH
602132	ADJUSTING AND REPAIRING EXISTING MANHOLE	EACH
602133	ADJUSTING AND REPAIRING EXISTING JUNCTION BOX	EACH

SECTION 604 — TEMPORARY WORKS

604.1 Description.

This work consists of constructing and removing temporary facilities used to perform the work.

604.2 Materials.

A.	Sheet Piles	Section 1032
B.	Steel	Section 1039
C.	Timber	Section 1041
D.	Form Oil	Section 1049

604.3 Construction.

604.3.1 Submittals.

A. Prepare and submit working drawings for the temporary works at least 30 calendar days in advance of beginning the work, in accordance with Section 105.4. Include materials list, fabrication and erection details, jacking support plan, design calculations, and supporting data in sufficient detail to allow a structural review of the proposed design of a temporary work. Use a registered Delaware professional engineer to design and seal drawings and calculations for the temporary works in accordance with AASHTO LRFD Bridge Design Specifications, the Guide Design Specifications for Bridge Temporary Works, or to other design requirements in accordance with the contract.

B. Submit working drawings for form liners indicating the layout of panels, details of all surface and joint patterns, and details for wrapping the form liner around corners in accordance with Section 604.3.3. Submit a form liner sample.

C. Unless otherwise noted in the contract, the minimum clearance over roadways, including the traveled way and the shoulder, is as follows:

1. 14 1/2-feet for interstates and other controlled access highways.
2. 14-feet for all other roadways.

   The Department will not allow any part of the temporary works system to encroach on clearance restrictions over the roadway and shoulders.

D. Start fabrication or construction only after approval of the working drawings. Construct temporary works in conformance with the approved working drawings.

604.3.2 Falsework and Formwork.

A. Provide rigid and strong falsework and forms to safely support the imposed loads. Set and hold forms true to the dimensions, lines, and grades of the structure before and during concrete placement.

1. Construct falsework and set grades that allow for settlement and deflection. Provide the vertical alignment and camber indicated for the permanent structure. Allow for minor adjustments during concrete or structural steel placement. Attach an approved indicator to the forms to

detect settlement, movement, or deflection in the falsework. Provide for accurate measurement of falsework settlement during concrete placement and curing.

2. For concrete surfaces exposed to view, provide formwork that will produce a smooth surface of uniform texture. Use rigid forms to ensure a concrete surface tolerance of less than 1/8-inch in 5-feet when checked with a 5-foot straightedge or template. Fillet sharp corners with 3/4-inch chamfer strips. Bevel or chamfer at projections, such as copings, to ensure easy removal.
3. Support falsework or formwork for deck slabs on girder bridges directly on the girders. Brace and tie girders to resist forces that could cause rotation or torsion in the girders. Do not weld falsework support brackets or braces to structural steel members or reinforcing steel unless specified in the contract or allowed by the engineer.
4. Do not brace concrete forms against a cofferdam or shoring unless approved by the engineer.
5. In narrow walls and columns, where the bottom of the form is inaccessible, provide an access opening in the forms for cleaning immediately before placing the concrete. For thin wall construction, daylight forms at intervals no greater than 10-feet vertically to permit free access to the forms for working, vibrating the concrete, and inspection.
6. For roadways remaining open to traffic during construction, provide 5-feet of horizontal clearance between the falsework and the traveled way.

B. Accessories.

1. Treat forms with form oil or other approved release agent before placing reinforcing steel.
2. Mechanically fasten embedded accessories to the formwork.
3. Construct metal ties or anchorages within the forms capable of removal to a depth of at least 1-inch below the concrete surface. If the contract specifies epoxy-coated reinforcing steel, use embedded ties, anchorages, or spreaders of corrosion-resistant material or coated with a dielectric material. Design fittings for metal ties to minimize the size of the cavities remaining after removal.
4. Remove wood blocks and bracing within the forms. Do not leave any portion of the wood forms in the concrete.
5. Clean forms, inspect for damage, and, if necessary, repair before reuse.

C. Design and fabricate cardboard tubes for placement in forms to produce voids in concrete slabs and box beams. Fabricate the tubes with waterproof outside layers. Protect tubes from the weather. Place tubes using methods that prevent distortion or damage before concrete placement. Cover the ends of tube forms with mortar-tight and waterproof caps to prevent concrete from entering the tubes during concrete placement. Use a pre-molded rubber joint filler, 1/4-inch thick, around the perimeter of the caps to allow for expansion. Provide a PVC vent tube at the location indicated in the contract, to provide drainage from the voids. 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. The contractor may use styrofoam blocks instead of cardboard tubes provided they are anchored to prevent displacement during pouring.

D. Falsework or Form Removal.

1. After placing concrete, maintain falsework or forms as required in Table 610.3-3.

2. When removing falsework and forms:
   a. Do not damage the concrete surface.
   b. Allow the structure to uniformly and gradually take the stresses resulting from the dead load.
3. Remove falsework and forms, except as noted below.
   a. When removal would damage completed structures, cut off portions of temporary piles or sheet piles as follows:
      i. 12-inches or more below subgrade within roadbeds.
      ii. 24-inches below the original ground or finished grade outside of roadbeds and 24-inches below the established limits of any navigation channel.
   b. Footing forms if removal endangers the safety of cofferdams or other work.
   c. Forms from inaccessible enclosed cells.
   d. Deck forms in the cells of box girder bridges that do not interfere with the future installation of utilities shown in the contract.

604.3.3 Form Liners.

A. Liners.
   1. Provide liners that:
      a. Will produce the finish details specified in the contract;
      b. are reusable and made of high strength urethane;
      c. capable of withstanding anticipated pour pressures without leakage causing physical or visual defects and that do not compress more than 1/4-inch when poured vertically at a rate of 10 feet per hour;
      d. attach easily to the formwork system and are removable without causing concrete surface damage or weakness in the substrate; and
      e. capable of assembling into varying pattern configurations.

B. Patterns and Joints.
   1. Use a random form liner panel layout that does not repeat the same pattern on adjacent panels or on a series of panels.
   2. Stagger panel joints so that long continuous horizontal or vertical lines do not appear in the finished concrete surface. Offset horizontal joints between adjacent vertical stacks of form liner panels.
   3. Blend butt joints between form panels into the approved pattern and the final finished concrete surface. Avoid creating visible vertical or horizontal seams or conspicuous form marks within the finished concrete surface.
   4. Use form liners capable of continuing patterns around corners.

C. Sample Panels and Test Sections.

1. When called for in the contract, construct sample panels to demonstrate the form liner patterns. Locate the sample panel as close as practicable to the structure for use as a basis of comparison to the work constructed on the finished structure.
2. When not using sample panels, the engineer will choose a portion of the finished structure as a test section.
3. Once the engineer approves the sample panel or test section, continue with construction of the proposed structural elements using form liners.
4. Remove rejected sample panels or test sections. Re-construct new sample panels or test sections until the engineer approves an acceptable unit.

D. Construction.

1. Attach form liners to the formwork system in accordance with the manufacturer's recommendations and with less than a 1/4-inch seam.
2. Before each pour, clean form liners and inspect each liner for blemishes and tears. Repair in accordance with the manufacturer's recommendation.
3. Use form stripping methods, form oil, or release agents compatible with the surface finish and application of the aesthetic stain.
4. Construct proposed structural elements using form liners to produce the same texture, pattern, and joint size as the approved sample panel or test section.
5. Repair damage created by form liner removal using patching material that matches the texture and color of the surrounding concrete.

604.3.4 Jacking Bridge.

A. Construct jacks in accordance with the approved jacking support plan and:

1. Ensure jacks used for jacking operations show the rate capacity on the manufacturer's name plate attached to each jack.
2. Use the shielded metal-arc process for all field welding. Weld in accordance with Section 615. The engineer may waive the radiographic and ultrasonic inspection requirements if the welds appear satisfactory after a visual inspection.

B. Thoroughly clean areas under the jacks to provide a flat, clean jacking surface.

C. Adhere to the following requirements and restrictions during the jacking sequences:

1. The engineer, or a representative, will inspect and approve jacking operations and will check all contract dimensions and requirements before allowing jacking operations to start.
2. If using jacks with a higher capacity than those listed in the contract, monitor the jack load to ensure the safety of the structure.
3. Equip the jack system with a gauge to read the jacking force in pounds or kips or equip the system with a chart that allows conversion of the dial reading into pounds.
4. Do not exceed the maximum jacking forces shown in the contract.
5. Do not use the jack hydraulics to support the load after jacking. Transfer all loads to the jacking supports after jacking.

6. Repair areas of the existing structure damaged during the jacking operation in accordance with Section 628.

604.3.5 Protective Shield.

A. Provide and erect a shield under the work area to protect vehicular, railway, and pedestrian traffic against damage from falling demolition or construction debris.

B. Extend the protective shield a minimum of 5-feet beyond all sides of a full depth concrete deck removal process, unless otherwise noted in the contract. Supplement the shields with additional enclosures of tarpaulins or wire mesh, as necessary, to ensure against materials, tools, equipment, and other objects dropping below the level of the shield. Ensure that the floor and sides of the shield have no cracks or openings through which material particles may fall. Install all connections of the protective structures to the steel work of existing bridge by means of clamps or other approved devices. Do not drill holes in, or weld anything to, the existing steel.

C. Do not use the shield for storing or stockpiling construction materials.

D. Remove broken concrete and other debris promptly so that material does not accumulate on the shield.

E. Remove and dispose of the protective shield after the engineer's approval.

604.3.6 Cofferdams.

A. Construct cofferdams in accordance with the approved working drawings to protect new concrete against flooding damage during the concrete curing period. Provide a cofferdam to obtain, as nearly as possible, a water-free work area large enough to allow for a sump and for form inspection.

B. Remove cofferdams, including all sheeting and bracing, after completing the substructure work. Portions of cofferdams may remain in place in accordance with Section 604.3.2.D when approved by the engineer.

604.3.7 Shoring.

A. Construct shoring in accordance with the approved working drawings to stabilize phased construction activities. Provide rigid and strong shoring to safely support the imposed loads and allow for construction activities adjacent to facilities remaining in service, as required in the contract.

B. Remove shoring when no longer needed.

C. Portions of shoring may remain in place in accordance with Section 604.3.2.D when approved by the engineer.

604.3.8 Wetland Access.

A. Temporary Matting.

Access wetlands and subaqueous lands using temporary matting to support equipment loads. Use timber or composite material for temporary mats. Use a matting system with interlocking panels to distribute loads and anchored to resist high water flows.

B. Tree Removal.

1. Clear only trees directly in conflict with the needed access. Flag these trees and obtain approval from the engineer before beginning the clearing operation.
2. During tree removal, do not enter wetlands with earthmoving equipment. Remove felled trees using a winch or other similar equipment.
3. Cut trees as close to the existing ground as possible without disturbing the root mat. Do not perform stump removal. Do not grub in wetland areas.

C. Where shown in the contract, construct and maintain SCEs to access wetlands areas as follows:

1. Do not compact soils in wetland areas.
2. Place geotextile fabric on existing ground.
3. Place stone on the geotextile fabric to provide a stable surface. Ensure that the stone does not extend beyond the edges of the geotextile fabric. Determine the thickness and type of stone capable of supporting the anticipated equipment.

D. After closing the wetland access, remove and dispose of all materials. Restore disturbed wetland areas to their preconstruction condition.

604.3.9 Temporary Works Removal.
Remove and retain or dispose of materials used for temporary works after completing the work. If construction of temporary works disturbed the area where the temporary works were placed, restore the area to its original or planned condition.

604.4 Method of Measurement.

A. The Department will not measure quantities for bridge jacking, protective shields, cofferdams, shoring, or wetland access.

B. The Department will measure the quantity of form liners by the square feet of concrete surface area that the contractor used the form liners on. The Department will measure the approved sample panel as an additional concrete surface area.

604.5 Basis of Payment.

A. The Department will consider the cost of falsework and formwork as incidental to the item requiring the use of the temporary work.

B. Price and payment for form liners constitute full compensation for:

1. Submittals and working drawings;
2. providing form liners; and
3. installing and removing form liners within the formwork system.

C. Price and payment for jacking bridge constitute full compensation for:

1. Submittals and working drawings;
2. providing jacking supports;
3. hydraulic jacks; and
4. temporary blocking or shims.

D. Price and payment for protective shield constitute full compensation for:

1. Submittals and working drawings;
2. providing and placing all materials;
3. performing the work in accordance with the contract; and
4. removal and disposal of the protective shield materials.

E. Price and payment for cofferdams or shoring constitute full compensation for:

1. Submittals and working drawings;
2. providing and placing materials;
3. performing the work in accordance with the contract; and
4. cofferdam or shoring material removal and disposal.

F. If directed to leave cofferdam or shoring system or parts of the system in place, the Department will pay the cost of the materials left in place.

G. If the work requires structural excavation, the Department will consider the cost of shoring used to stabilize structural excavation as incidental to Section 207.

H. The Department will pay for items related to wetland access as follows:

1. Price and payment for temporary matting constitute full compensation for providing, placing, maintaining, and removing temporary matting materials and for restoring the wetland access area to preconstruction conditions.
2. Clearing in accordance with Section 201.
3. Seeding and stabilized construction entrances in accordance with Section 908.

ITEM	DESCRIPTION	UNIT
604000	JACKING BRIDGE	LS
604001	PROTECTIVE SHIELD	LS
604002	COFFERDAMS	LS
604003	SHORING	LS
604004	WETLAND ACCESS	LS
604005	FORM LINERS	SF

SECTION 605 — DRIVEN PILES

605.1 Description.

This work consists of providing, installing and dynamically testing foundation piles.

605.2 Materials.

A.	Reinforcing Steel	Section 611 and 1037
B.	PCC, Class A	Section 1022
C.	Steel Shell Piles	Section 1032.3.1
D.	Precast, Prestressed Concrete Piles	Section 1032.5
E.	Steel H Piles	Section 1032.4
F.	Timber Piles	Section 1032.2
G.	Metal Sheets	Section 1039.9
H.	Epoxy Grout	Section 1047.4

605.3 Construction.

605.3.1 Submittals.

A. Submit working drawings showing:

1. Details of the proposed pile;
2. splice details if proposing an alternate to the contract details;
3. procedures for lifting, transporting, and handling piles; and
4. for precast concrete piles, include details of the reinforcement and prestressing strands; and
5. for cast-in-place piles, include the proposed method of securing the reinforcement bar in position during concrete placement.

B. Pile Installation Equipment.

1. At least 30 calendar days before driving piles, submit technical specifications for the proposed pile driving system to the engineer for approval. Use Figure 605.3C-1 DelDOT Pile and Driving Equipment Data Form.
2. Provide the engineer with a chart from the hammer manufacturer, equating stroke and blows per minute for the hammer in use.

C. Pile Testing Firm.

1. Employ a pile testing firm experienced in high-strain dynamic monitoring of driven piles to conduct load tests, record all data, and provide test result reports to the engineer.
2. Use a pile testing firm with at least 5-years of documented experience in performing and interpreting dynamic pile testing.
3. Ensure that the testing firm's field engineer or technician operating the instrumentation and collecting the data has documented experience on at least 10 previous projects with similar pile

requirements and possesses a valid certificate of proficiency issued by the Pile Driving Contractors Association (PDCA).

4. Ensure that the field engineer or technician is capable of understanding and interpreting the collected data during pile driving.
5. Submit the pile testing firm qualifications for dynamic testing to the engineer for approval with the wave equation analysis submittal. The engineer will review the firm's qualifications and applicable previous experience on other projects.

D. Wave Equation Analysis Requirements.

1. Use the wave equation analysis to verify the adequacy of each proposed pile driving system. A registered Delaware professional engineer will sign and seal each analysis. Submit the wave equation analysis to the engineer 30 calendar days before driving test piles.
2. Include a static soil analysis with the wave equation analysis. If the contractor's static analysis predicts a need for alternate test pile lengths, clearly indicate the lengths of test piles in the submittal.
3. Use the wave equation analysis 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.
4. 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.
5. Perform a wave equation analysis for each test pile. Evaluate drivability of the pile to various depths of penetration using the proposed driving system. At a minimum, 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. Perform additional analysis at depths where the possibility exists of difficult driving or significant changes in drivability. A value of 100 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 chosen wave equation analysis estimate is used for 100 percent penetration.
6. 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. At 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.
7. If the driving equipment consists of a varying energy or varying stroke type hammer, perform an additional analysis that plots blow count versus stroke and energy for a fixed resistance equal to the ultimate resistance.
8. 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.

9. Select a hammer that drives the pile without exceeding the following permissible stress limits:
   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, the environmental exposure level will be as shown in the contract.
      i. For normal exposure, the maximum permissible tensile stress is 3 multiplied by the square root of the concrete compressive strength, f c ’, plus the effective prestress value, fpe, or 3√fc ’ + fpe, with all units expressed in PSI.
      ii. For severe exposure, the maximum permissible tensile stress is fpe.
      iii. For all exposure conditions, the maximum permissible compressive stress is 85 percent of the compressive strength minus the effective prestress value, or 0.85 fc ’ - fpe.
   c. For timber piles, the maximum permissible compressive driving stress is 3 times the permissible static design strength listed in the contract.

E. The engineer will complete the conformance review and comment on the driving system within 14 calendar days of receiving the contractor's Pile and Driving Equipment Data Form and wave equation analysis. Modify or replace the proposed methods or equipment for nonconforming analysis. The engineer will complete the conformance review of the revised driving system within 7 calendar days of receipt of a revised Pile and Driving Equipment Data Form and wave equation analysis.

F. If there is a change to the pile driving system, submit the necessary wave equation analysis, drive additional test piles, and perform dynamic pile testing, as directed by the engineer, before driving any production piles.

G. Post-driving Reporting.

1. Prepare and submit a written report with the results of the test pile program, within 3 working days of the completion of each dynamic test. Include the following:
   a. Meet the requirements of ASTM D4945;
   b. summary of the pile driving system used during dynamic testing;
   c. summary of dynamic testing instrumentation and methods utilized;
   d. performance of the hammer and driving system including:
      i. Maximum transferred energy,
      ii. blows per minute, and
      iii. ram stroke;
   e. pile integrity:
      i. indicate instances of pile overstressing during driving and
      ii. indicate instances of pile damage or broken piles;
   f. provide the following data for the full length of driving at intervals of no more than 10 hammer blows:

i. bearing resistance from the case method and 1 additional recognized method,

ii. pile penetration depth and corresponding blow sequence, and

iii. maximum compressive and tensile driving stresses;

g. detailed results of the signal matching analyses; and

h. driving logs recorded in the field.

2. Perform signal matching analyses for the initial drive and each re-strike of dynamically tested piles as follows:

a. One for a representative blow near the end of each initial drive.

b. Two representative blows towards the beginning of each re-strike.

c. One additional signal matching analysis at the request of the engineer.

605.3.2 Pile Installation Equipment.

A. Pile Hammers.

1. Use air, steam, diesel, or hydraulic hammers for driving piles.

a. Air and Steam Hammers:

Equip the plant and equipment with easily accessible pressure gauges. Ensure that the weight of the striking parts of air and steam hammers are at least 1/3 the weight of the helmet and pile being driven, but in no case less than 2,750-pounds.

b. Diesel Hammers

Equip open-end, single-acting diesel hammers with a device to allow the engineer to visually determine hammer stroke at all times during pile driving.

c. Hydraulic Hammers

Equip the power plant and equipment with easily accessible pressure gauges.

B. Hammer Cushion.

1. Provide hammer cushions made of durable manufactured materials, provided in accordance with the hammer manufacturer's guidelines. Do not use wood, wire rope, or 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.

C. Helmet.

1. Piles driven with impact hammers require an adequate helmet or drive head to distribute the hammer blow to the pile head. Use leads to guide the helmet and prevent it from swinging freely. Use the correct helmet or drive head size to appropriately fit the pile head, to hold the axis of the pile in line with the axis of the hammer, and to prevent eccentric impacts on the pile head.

D. Pile Cushion

1. Protect the heads of precast concrete piles with a pile cushion made of plywood, hardwood, or composite plywood and hardwood materials. Ensure the pile cushion dimensions prevent movement within the helmet during driving. Provide pile cushion of the thickness specified in the wave equation submittal or as determined from the results of dynamic testing. The engineer will evaluate the use of manufactured pile cushion materials instead of a wood pile cushion on a case-by-case basis.

E. Leads.

1. Use leads to support piles in line and position while driving. Construct pile driver leads to allow the hammer to move freely while maintaining alignment with the pile to ensure concentric impact for each blow. The contractor may use either 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. Provide leads of sufficient length to raise the hammer into a clear position while placing the pile in the leads and with the leads embedded.

F. Followers.

1. Only use followers when approved in writing by the engineer, or when specifically stated in the contract. In cases of follower allowance, drive the first pile in each bent, and every tenth pile driven thereafter, full-length without a follower, to determine adequate pile penetration attainment in order to develop the ultimate pile resistance.

2. Hold and maintain the follower and pile in equal and proper alignment during driving. Use a follower of the material and dimensions that allows driving the piles to the penetration depth as determined necessary from the driving of the full-length piles. Verify the final position and alignment of the first 2 piles installed with followers in each substructure unit, according to the location tolerances specified in Section 605.3.6.A before installing additional piles.

605.3.3 Preparation and Driving of Test Piles.

A. Preparation.

1. Provide equipment and perform testing and reporting procedures in strict accordance with ASTM D4945 - Standard Test Method for High-Strain Dynamic Testing of Piles.

2. Perform the wave equation analysis based on the procedure outlined in Section 605.3.1.D. Do not drive test piles prior to approval of the wave equation analysis.

3. Provide test piles in 1 length as indicated in the contract to allow for uninterrupted driving during dynamic testing, unless otherwise approved by the engineer.

4. Prepare all test piles for instrumentation attachment.

5. Ensure that test piles are the initial piles driven and are the same material and dimensions as the production piles. Install test piles at the locations indicated in the contract.

B. Driving with Dynamic Load Tests.

1. Drive test piles in accordance with Section 605.3.4 with the following additional procedures.

2. Before installing the dynamic monitoring instrumentation on the pile, including all gauges and cables, lift the pile and align in the leads, and set the hammer and helmet. Once the pile set and the pile driving system is in place, attach dynamic monitoring instrumentation.

3. Perform dynamic testing during the entire initial drive and re-strike of all test piles so designated in the contract, or as otherwise directed by the engineer. Continuously monitor the tensile and compressive stresses during driving to prevent exceeding permissible stress limits during driving. Immediately reduce the hammer stroke or stop the driving operation if stresses in the pile approach, or exceed, the permissible limits. If non-axial driving appears by dynamic test measurements, stop pile driving immediately and realign the driving system, or take other corrective action, before resuming driving.
4. If the top of the pile becomes damaged or deformed at any time during the dynamic pile testing, stop pile driving and cut off the damaged area in accordance with Section 605.3.4.B. Prepare the remaining pile section for gauge installation. After the engineer inspects and approves, continue driving.
5. Drive all dynamically tested piles deep enough to achieve the minimum tip elevation and the minimum initial driving resistance. Do not exceed the permissible stress limits.
6. Maintain a minimum distance of 1-foot between the pile monitoring gauges and the ground surface, water surface, or pile template. If driving and dynamic testing are complete, remove the gauges.
7. If additional ground penetration becomes necessary, stop driving the pile, remove the gauges, and splice the pile before proceeding. Before splicing, properly prepare the pile splice segment for gauge installation, in accordance with ASTM D4945, and make it accessible to the engineer for inspection. After splicing the pile and resetting the hammer and leads, reattach the gauges to the new pile segment and continue the drive.
8. If some length of test pile remains above the cut-off elevation after completing dynamic testing, do not drive the remainder of the pile without the approval of the engineer.

C. Post-Driving.

1. 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 1 or more of the following requirements:
   a. Establish the driving criteria of required blow count, stroke height, and minimum tip elevation for the driving of production piles based on satisfactory test pile results. The engineer reserves the right to establish or modify the minimum tip elevation for all the piles, depending on the actual conditions encountered.
   b. When shown in the contract, issue a list of production pile lengths for fabrication of those piles governed by the test pile, or group of test piles, within 5 working days after completing test pile driving.
   c. Order a test pile re-strike, in accordance with Section 605.3.5, within 2 working days after completing the initial driving.
   d. Order a driving splice on the test pile within 2 working days after unsatisfactory results of the re-strike. Make the driving splice in accordance with the driving splice details shown in the contract. Upon completion of driving the spliced pile, the engineer will review the new driving records and make 1 of the above recommendations.
   e. Based on satisfactory test pile results, the engineer will accept the test pile for use as a production pile.

f. Approve the driven test pile for load testing when requiring static load testing. The engineer may select 1 of the above requirements before authorizing performance of a load test, or if a load test is unsatisfactory.

g. If the data and information obtained from driving any original test pile is conflicting, inconclusive, or unsatisfactory in any way, the engineer will order another test pile driven for additional information within 2 working days after receipt of the post-driving report.

2. When shown in the contract, perform static load tests on selected test piles. Perform static load tests in accordance with the procedures specified in ASTM D1143. Upon completion, the engineer will review the load test records and make 1 or more of the requirements in Section 605.3.3.C.1.

605.3.4 Preparation and Driving of Production Piles.

A. Preparation.

1. Clearly mark the pile in 12-inch increments with markings visible from a safe inspection distance.

2. Provide the engineer with reasonable inspection access along the full length and perimeter of all piles. Prior to installation, repair or replace piles with damage incurred during shipping, handling, or storage. Piles with any of these defects will cause rejection by the engineer:

a. Visible cracks or spalls in a concrete pile;

b. a bent, kinked, or distorted steel pile; or

c. damaged timber pile treatment of a timber pile or compromised integrity as outlined in Section 605.3.4.B.10 below.

3. Pile Driving Sequence.

a. Provide the engineer with schedules of the proposed driving sequence. Do not begin driving test or production piles at any location until the engineer approves the schedule for that location. Do not depart from these schedules without the prior approval of the engineer.

b. 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.

B. Driving.

1. Drive the production piles using the same pile driving system used to drive the test piles. For changes to the pile driving system, see Section 605.3.1.F.

2. Conduct the pile driving operations in close cooperation with the engineer and in a manner that allows the engineer to obtain essential measurements and data. The engineer will observe the progress of all pile driving work. The engineer will record a complete driving log for each pile driven. The driving log will list all data essential for the determination of correct bearing resistance.

3. Embed the leads in the ground or constrain the pile in a structural frame, such as a template, to maintain alignment of the pile during driving. Do not apply side pressure to move piles into the correct position for driving.

4. Place the tip of each pile in the correct plan location before attaching the helmet. Ensure the heads of all piles are in a true plane and perpendicular to the longitudinal axis of the pile before attaching the helmet.
5. Protect the heads of concrete piles with a pile cushion in accordance with Section 605.3.2.A.4. Secure the pile cushion within the helmet prior to attaching the helmet to the pile. Provide a new pile cushion for each pile. During the driving of a single pile, replace the pile cushion if the cushion is compressed more than 1/2 the original thickness or it begins to burn.
6. Drive each production pile continuously from the start until reaching the driving criteria from the test piles as established in Section 605.3.3.C, except as required for splicing the pile or replacement of the pile cushion.
7. Stop pile driving if the blow count exceeds 240-blows per 12-inches, or 20-blows per 1-inch of driving for 3 consecutive inches. Immediately inform the engineer if blow counts exceed these limits at a tip elevation above the minimum tip elevation specified.
8. Stop pile driving if the top of a pile is damaged or becomes deformed. Cut off piles perpendicular to the length to remove damage or deformations detrimental to the performance of the pile driving system or to the integrity of the pile. Allow steel piles to cool before continuing.
9. 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. The maximum allowable variation at the top of the pile is 3-inches in any direction from the location shown in the contract.
10. Construct driving splices in accordance with the contract or submit alternate details to the engineer for review and approval. After completing the splice, drive the spliced pile to meet the driving criteria. If it becomes necessary to splice timber piles, submit the method for splicing and driving to the engineer for written approval.
11. Survey the location, alignment, and top elevation of the piles after driving of each pile group. Provide the survey results to the engineer.
12. The engineer will reject piles damaged by improper driving or driven outside of the allowable tolerance specified.
    a. Remove and replace rejected piles. Alternately, drive a replacement pile or piles adjacent to the damaged pile, if driving of additional piles can occur without detriment to the structure, and if approved by the engineer.
    b. In addition, modify the footing or pile cap, as required by the engineer, to accommodate the out of tolerance or added piles.
13. 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 the original tip elevation, or as directed by the engineer. Remove any material forced up between the piles during driving to the correct elevation before placement of foundation concrete.

C. Post-driving.

1. The engineer will review the driving records and may provide 1 or more of the following responses depending on the what the driving records show:
    a. No further action needed.

b. Re-strike selected production piles. Perform the production pile re-strikes in accordance with the requirements of Section 605.3.5.

c. Dynamically test production pile re-strikes or subsequent production pile initial drives in accordance with the requirements of Section 605.3.3.

605.3.5 Pile Re-strike.

A. Preparation.

1. Within 2 working days after initial driving, the engineer may order a pile re-strike of test pile as a result of Section 605.3.3.C or of production piles as a result of Section 605.3.4.C when the contractor does not meet the driving criteria.
2. Perform the re-strike at least 48-hours, but no more than 7 calendar days, after initial driving unless otherwise noted in the contract. If pile installation continues adjacent to a pile requiring a re-strike, the engineer reserves the right to delay the re- strike until at least 48 hours after the contractor completes all adjacent pile driving.
3. Dynamically test all re-strikes of test piles. The engineer may require the contractor to dynamically test production pile re-strikes.
4. Perform re-strikes using the same pile driving system used to install the piles during initial driving.
5. Mark the pile in 1-inch increments for at least 12-inches for measurement of the pile movement during re-strike.
6. Establish the elevation of the top of pile using a survey level before performing the re- strike.

B. Driving.

1. Warm up the hammer and verify proper operation of the driving system by striking another pile or pile cut-off at least 20 blows at full stroke.
2. Lower and position the hammer on the pile. If necessary, connect dynamic monitoring instrumentation. Strike the pile 20 blows at the required stroke height.
3. If any component of the pile driving system does not function properly during the pile re- strike, perform additional re-strikes until the pile driving system operates properly through a complete continuous re-strike procedure in accordance with this Section.

C. Post-driving.

1. Use a survey level to establish the new top of pile elevation.
2. Following the pile re-strike, the engineer will review the driving records and, within 2 working days, make 1 or more of the following decisions:
   a. Accept a test pile for use as a production pile, based on satisfactory re-strike results.
   b. Establish the required re-strike blow count, stroke height, and acceptable top of pile elevation change for production piles re-strikes, based on satisfactory test pile re-strike results.
   c. Accept a production pile, or representative group of piles, if the pile re-strike results are satisfactory.
   d. Require additional ground penetration based on unsatisfactory pile re-strike results. The engineer may order:

i. An additional re-strike with a longer wait time;

ii. additional driving until the driving criteria is met or the full length of pile is driven, in cases where the top of pile remains above existing grade; or

iii. a driving splice, in cases where the top of pile reaches existing grade.

605.3.6 Additional Installation Requirements.

A. Non-Driving Pile Build-ups.

1. Construct all non-driving pile build-ups as shown in the contract or approved alternate.

B. Pile Cut-Offs.

1. Upon completion of pile driving, cut off all test and production piles to final elevation, in accordance with the contract. Dispose of cut-off material in accordance with Section 106.8.

a. Cut off steel shells or steel H-piles square to the pile, using an acetylene or electric torch.

b. Cut off precast concrete piles square to the pile. If insufficient length of inserts for dowel bars remains, deepen the remaining hole or drill a new hole of adequate length.

c. Saw timber piles that support a timber superstructure to conform to the plane of the bottom of the superimposed structure:

i. Treat all exposed sawed surfaces of timber piles in accordance with Section 1041.4.E.

ii. Install 2 layers of metal sheet covering of either 13-gauge zinc or 20-gauge copper a minimum of 4-inches greater than the diameter of the pile on top of the treatment.

(1) Bend excess metal down over the sides of the pile, trim, and nail.

(2) Fasten zinc sheets with 1-inch long galvanized, large-headed nails.

(3) Fasten copper sheets with 1-inch long copper nails.

2. Cover the tops of pre-stressed concrete piles or steel shell piles with plastic to prevent dirt and water from entering the pile until placement of grout or concrete. Remove dirt or water from holes or sleeves of pre-stressed concrete piles before grouting in bar reinforcement.

3. Cut off test piles driven outside permanent foundation locations at a point at least 24-inches below finished grade or final stream bed elevation, upon satisfactory completion of test driving,

C. Cast-in-place Concrete Piles.

1. Placement of Reinforcement Bar.

a. Assemble the longitudinal reinforcement bar 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.

b. Keep the interior of the reinforcement cage open to allow for the free flow of concrete into the pile shell. Do not use interior bracing or spacers.

c. Place the completed assembly in the driven steel shell and prevent displacement during concrete placement.

2. Concrete Placement.

a. Do not place concrete in steel shells until completion and acceptance of all driving within the same substructure unit. If it is not possible to follow this limitation, do not drive within the same substructure unit until the placed concrete reaches 50 percent of the 28-day strength.

b. Do not place concrete in a steel shell until removal of all water, dirt, and debris and approval by the engineer.

c. Place the concrete for each steel shell to ensure a dense, homogenous mass throughout the entire casing to provide a permanent bond with all bar reinforcement embedded in the pile.

d. Place concrete for each steel shell in a continuous operation. If the bar reinforcement caging or dowels occupy only the upper section of the pile, do not place bar reinforcement in the pile casing or shell until the concrete reaches the elevation of the lowest end of the bar reinforcement. At this point, set the bar reinforcement in the casing, and continue to place the concrete until reaching the cut-off elevation. Concrete must remain plastic throughout placement. When bar reinforcement caging or dowels occupy only the upper section of the pile, the contractor may place reinforcement before placing concrete if the contractor uses a tremie or similar piece of equipment that allows the contractor to deposit concrete in the portion of the pile below the bottom elevation of the reinforcement.

e. Do not disturb piles with freshly placed concrete until the concrete reaches 50 percent of the 28-day strength.

D. After completing all other parts of the structure, clean the exposed part of the piling of discoloration caused by construction.

605.4 Method of Measurement.

A. The Department will measure work acceptably completed in accordance with Section 109.1. The Department will measure the quantity of:

1. Provided piles by the total length of pile in linear feet.
2. Installed piles by the linear feet of pile in place below the cutoff elevation.
3. Dynamic pile testing for test pile initial drive as 1 each for each test pile driven.
4. Dynamic pile testing for restrike or production pile as 1 each for each re-strike on test or production pile tested and for each production pile initial drive tested.
5. Pile re-strikes by each re-strike performed.

605.5 Basis of Payment.

A. The Department will pay the quantity of provided test piles and production piles at the contract unit price per linear foot for each type of pile. Price and payment constitute full compensation for:

1. Providing all materials;
2. pile reinforcing tip, driving shoe, or closure plate for the respective pile type;
3. timber pile preservatives;
4. steel pile shells, protective coatings, bar and spiral reinforcement, and PCC for cast-in-place or steel pipe piles;
5. pre-stressing strands, bar and spiral reinforcement, dowels, and PCC for precast piles; and

6. pile splice and pile build-up materials.

B. The Department will pay for the installed quantity of test piles and production piles at the contract unit price per linear foot for each type of pile installed. Payment is full compensation for:

1. Driving of all pile types;
2. acceptably performing a pile cut off, and for the disposal of cut-off piles for all pile types;
3. placement of bar, spiral reinforcement, PCC for cast-in-place or steel pipe piles, and placement of metal sheeting atop timber piles;
4. drilling of holes, epoxy grout, and placement of dowels for precast piles; and
5. pile splices and pile build-ups as additional linear feet of pile installed.

C. The Department will pay for driving additional test piles, as required by the engineer, as an extra quantity of test piles under this section.

D. The Department will pay for pile re-strikes authorized by the engineer at the contract unit price per each. Price and payment will constitute full compensation for all work associated with the set up and conducting the pile re-strikes, except for dynamic pile testing of re-strikes.

E. Dynamic pile testing of test pile initial drives authorized and accepted by the engineer at the contract unit price per each. Payment is full compensation for:

1. Providing a pile testing firm;
2. preparation of the wave equation analysis;
3. providing inspection access to the Department and all materials, equipment and incidental work required to perform dynamic pile testing during initial driving;
4. completion of the signal matching analysis; and
5. completion of post-driving reports.

F. Dynamic pile testing of re-strikes and production piles authorized and accepted by the engineer at the contract unit price per each. Payment is full compensation for:

1. Providing inspection access to the Department and all materials, equipment, and incidental work required to perform dynamic pile testing during re-strikes or production pile driving;
2. completion of the signal matching analysis; and
3. completion of post-driving reports.

ITEM	DESCRIPTION	UNIT
605000	PROVIDE TIMBER PILES - TREATED, 12"	LF
605001	PROVIDE TIMBER PILES - TREATED, 14"	LF
605002	PROVIDE TIMBER PILES - TREATED, 16"	LF
605010	PROVIDE CAST-IN-PLACE CONCRETE PILES, 12"	LF
605011	PROVIDE CAST-IN-PLACE CONCRETE PILES, 14"	LF

ITEM	DESCRIPTION	UNIT
605012	PROVIDE CAST-IN-PLACE CONCRETE PILES, 16"	LF
605013	PROVIDE CAST-IN-PLACE CONCRETE PILES, 18"	LF
605020	PROVIDE STEEL H PILES, HP 10 X 42	LF
605021	PROVIDE STEEL H PILES, HP 12 X 53	LF
605022	PROVIDE STEEL H PILES, HP 12 X 63	LF
605023	PROVIDE STEEL H PILES, HP 12 X 74	LF
605024	PROVIDE STEEL H PILES, HP 14 X 73	LF
605025	PROVIDE STEEL H PILES, HP 14 X 89	LF
605026	PROVIDE STEEL H PILES, HP 14 X 102	LF
605030	PROVIDE STEEL PIPE PILES, 24"	LF
605031	PROVIDE STEEL PIPE PILES, 30"	LF
605032	PROVIDE STEEL PIPE PILES, 36"	LF
605033	PROVIDE STEEL PIPE PILES, 48"	LF
605034	PROVIDE STEEL PIPE PILES, 12"	LF
605040	PROVIDE PRECAST PRESTRESSED CONCRETE PILES, 12" X 12"	LF
605041	PROVIDE PRECAST PRESTRESSED CONCRETE PILES, 14" X 14"	LF
605042	PROVIDE PRECAST PRESTRESSED CONCRETE PILES, 16" X 16"	LF
605043	PROVIDE PRECAST PRESTRESSED CONCRETE PILES, 18" X 18"	LF
605044	PROVIDE PRECAST PRESTRESSED CONCRETE PILES, 20" X 20"	LF
605045	PROVIDE PRECAST PRESTRESSED CONCRETE PILES, 24" X 24"	LF
605046	PROVIDE PRECAST PRESTRESSED CONCRETE PILES, 30" X 30"	LF
605050	PROVIDE TIMBER TEST PILES - TREATED, 12"	LF
605051	PROVIDE TIMBER TEST PILES - TREATED, 14"	LF
605052	PROVIDE TIMBER TEST PILES - TREATED, 16"	LF
605060	PROVIDE CAST-IN-PLACE CONCRETE TEST PILES, 12"	LF
605061	PROVIDE CAST-IN-PLACE CONCRETE TEST PILES, 14"	LF
605062	PROVIDE CAST-IN-PLACE CONCRETE TEST PILES, 16"	LF
605063	PROVIDE CAST-IN-PLACE CONCRETE TEST PILES, 18"	LF
605070	PROVIDE STEEL H TEST PILES, HP 10 X 42	LF
605071	PROVIDE STEEL H TEST PILES, HP 12 X 53	LF
605072	PROVIDE STEEL H TEST PILES, HP 12 X 63	LF
605073	PROVIDE STEEL H TEST PILES, HP 12 X 74	LF
605074	PROVIDE STEEL H TEST PILES, HP 14 X 73	LF
605075	PROVIDE STEEL H TEST PILES, HP 14 X 89	LF
605076	PROVIDE STEEL H TEST PILES, HP 14 X 102	LF

ITEM	DESCRIPTION	UNIT
605080	PROVIDE STEEL PIPE TEST PILES, 24"	LF
605081	PROVIDE STEEL PIPE TEST PILES, 30"	LF
605082	PROVIDE STEEL PIPE TEST PILES, 36"	LF
605083	PROVIDE STEEL PIPE TEST PILES, 48"	LF
605084	PROVIDE STEEL PIPE TEST PILES, 12"	LF
605090	PROVIDE PRECAST PRESTRESSED CONCRETE TEST PILES, 12" X 12"	LF
605091	PROVIDE PRECAST PRESTRESSED CONCRETE TEST PILES, 14" X 14"	LF
605092	PROVIDE PRECAST PRESTRESSED CONCRETE TEST PILES, 16" X 16"	LF
605093	PROVIDE PRECAST PRESTRESSED CONCRETE TEST PILES, 18" X 18"	LF
605094	PROVIDE PRECAST PRESTRESSED CONCRETE TEST PILES, 20" X 20"	LF
605095	PROVIDE PRECAST PRESTRESSED CONCRETE TEST PILES, 24" X 24"	LF
605096	PROVIDE PRECAST PRESTRESSED CONCRETE TEST PILES, 30" X 30"	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
605133	INSTALL STEEL PIPE PILES, 48"	LF
605134	INSTALL STEEL PIPE PILES, 12"	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

ITEM	DESCRIPTION	UNIT
605146	INSTALL PRECAST PRESTRESSED CONCRETE PILES, 30" X 30"	LF
605150	INSTALL TIMBER TEST PILES - TREATED, 12"	LF
605151	INSTALL TIMBER TEST PILES - TREATED, 14"	LF
605152	INSTALL TIMBER TEST PILES - TREATED, 16"	LF
605160	INSTALL CAST-IN-PLACE CONCRETE TEST PILES, 12"	LF
605161	INSTALL CAST-IN-PLACE CONCRETE TEST PILES, 14"	LF
605162	INSTALL CAST-IN-PLACE CONCRETE TEST PILES, 16"	LF
605163	INSTALL CAST-IN-PLACE CONCRETE TEST PILES, 18"	LF
605170	INSTALL STEEL H TEST PILES, HP 10” X 42”	LF
605171	INSTALL STEEL H TEST PILES, HP 12” X 53”	LF
605172	INSTALL STEEL H TEST PILES, HP 12” X 63”	LF
605173	INSTALL STEEL H TEST PILES, HP 12” X 74”	LF
605174	INSTALL STEEL H TEST PILES, HP 14” X 73”	LF
605175	INSTALL STEEL H TEST PILES, HP 14” X 89”	LF
605176	INSTALL STEEL H TEST PILES, HP 14” X 102”	LF
605180	INSTALL STEEL PIPE TEST PILES, 24"	LF
605181	INSTALL STEEL PIPE TEST PILES, 30"	LF
605182	INSTALL STEEL PIPE TEST PILES, 36"	LF
605183	INSTALL STEEL PIPE TEST PILES, 48"	LF
605184	INSTALL STEEL PIPE TEST PILES, 12"	LF
605190	INSTALL PRECAST PRESTRESSED CONCRETE TEST PILES, 12" X 12"	LF
605191	INSTALL PRECAST PRESTRESSED CONCRETE TEST PILES, 14" X 14"	LF
605192	INSTALL PRECAST PRESTRESSED CONCRETE TEST PILES, 16" X 16"	LF
605193	INSTALL PRECAST PRESTRESSED CONCRETE TEST PILES, 18" X 18"	LF
605194	INSTALL PRECAST PRESTRESSED CONCRETE TEST PILES, 20" X 20"	LF
605195	INSTALL PRECAST PRESTRESSED CONCRETE TEST PILES, 24" X 24"	LF
605196	INSTALL PRECAST PRESTRESSED CONCRETE TEST PILES, 30" X 30"	LF
605200	PILE RESTRIKE	EACH
605201	DYNAMIC PILE TESTING BY CONTRACTOR FOR TEST PILE INITIAL DRIVE	EACH
605202	DYNAMIC PILE TESTING BY CONTRACTOR FOR RE-STRIKE OR PRODUCTION PILE	EACH
605210	STATIC LOAD TEST FOR DRIVEN PILES	EACH

SECTION 606 — DRILLED SHAFTS

606.1 Description.

This work consists of constructing drilled shafts.

606.2 Materials.

A.	Self-Consolidating PCC, Class A	Section 1022 and 1036
B.	Access Tubes for Crosshole Sonic Log Testing	Section 1033
C.	Steel Casings	Section 1034
D.	Slurry	Section 1035
E.	Reinforcing Steel	Section 1037
F.	Access Tube Grout	Section 1047.3
G.	Grout for Abandoned Exploratory Drilling in accordance with DNREC's Regulations Governing the Construction and Use of Wells, Section 5.8.12.1	
H.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7

606.3 Construction.

606.3.1 Submittals, Approvals, and Meetings.

A. At the time of bid, submit the drilled shaft and exploratory drilling specialty contractor qualifications verifying successful completion of at least 3 separate foundation projects within the last 5-years. Ensure that the 3 projects submitted involved drilled shafts and exploratory drilling of similar diameter, depth, and subsurface geotechnical conditions as those shown in the contract. Include a brief description of each project and the owner's contact person's name and current phone number for each project listed.

B. Experience and Personnel.

1. Submit a list, identifying the on-site supervisors and drill rig operators assigned to the project. 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.
2. Provide on-site supervisors with a minimum of 2-years of experience in supervising drilled shaft foundations of similar diameter and depth and geotechnical conditions as those shown in the contract. Direct supervisory responsibility for the on-site drilled shaft construction operations is necessary to satisfy the Department's work experience requirement. Unacceptable experience includes project management level positions that indirectly supervised on-site drilled shaft construction operations.
3. Drill rig operators must have a minimum of 1-year of experience in construction of drilled shaft foundations.
4. The engineer will approve or reject the contractor's qualifications and field personnel within 10 working days after receipt of submission. Do not start work on any drilled shaft until the engineer approves the contractor's qualifications and field personnel. The engineer may suspend the drilled shaft construction if the contractor substitutes field personnel without prior

approval by the engineer. The contractor shall accept full responsibility for the additional time resulting from the suspension of work and the Department will make no adjustments in contract time resulting from such suspension of work.

C. Drilled Shaft Installation Plan.

1. In preparing the submission narrative, reference the available subsurface geotechnical data provided in the contract documents and any geotechnical reports prepared for this project. Do not begin work until receipt of the engineer's written approval of all the required submittals. Provide at a minimum the following information:

   a. A description of overall construction operation sequence and the sequence of drilled shaft construction when in groups or lines.

   b. A list, description, and capacities of all proposed equipment. Describe the reasons for selecting the proposed equipment and describe equipment suitability for 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.

      i. Use excavation and drilling equipment capable of excavating to a depth 20 percent beyond the maximum shaft length shown in the contract.

   c. Drilled shaft excavation methods, including proposed drilling methods, methods for cleanout of the bottom of the drilled hole, and a disposal plan for excavated material and drilling slurry. Include a review of method suitability to the anticipated site and subsurface geotechnical conditions, including boulder and obstruction removal techniques if such are indicated in the contract subsurface geotechnical information or contract.

   d. The Department will not allow blasting unless specifically stated in the contract or authorized in writing by the engineer.

   e. Methods used to ensure drilled shaft hole stability during excavation and concrete placement. Include a review of method suitability to the anticipated site and subsurface geotechnical conditions.

   f. Procedures for mixing, using, maintaining, and disposing of slurry. Provide a detailed mix design including all additives and the specific purpose of additives in the slurry mix and a discussion of its suitability to the anticipated subsurface geotechnical conditions for the proposed slurry.

   g. A quality control plan for the slurry. Include details for the planned tests and test methods and the minimum and maximum property requirements the slurry must meet to show that the slurry will function as intended in the anticipated subsurface conditions and shaft construction methods. At a minimum, include the following tests in the slurry quality control plan as shown in Table 606.3-1:

Table 606.3-1. Minimum Tests Required in the Slurry 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

h. Reinforcing steel working drawings with details of reinforcement placement including:
   i. Type and location of splices;
   ii. reinforcement cage support and centralization methods;
   iii. bracing and extra reinforcing steel required for fabrication of the reinforcement cage;
   iv. type and location of all spacers;
   v. thermal integrity profiling thermal wire cables;
   vi. access tubes for cross hole sonic log testing and other instrumentation; and
   vii. procedures for lifting and setting the reinforcement cage.

i. When proposed or required, provide the following casing information:
   i. Casing dimensions and detailed procedures for permanent casing installation;
   ii. temporary casing installation and removal; and
   iii. methods of advancing the casing, along with the means used for excavating the drilled shaft hole in accordance with Section 606.3.5.

j. 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.

k. Concrete placement details including:
   i. Proposed equipment and procedures for delivering concrete to the drilled shaft;
   ii. placement of the concrete into the shaft;
   iii. initial placement and raising of the tremie or pump line during placement;
   iv. size of tremie and pump lines;
   v. operational procedures for pumping;
   vi. sample uniform yield form for plotting concrete volume placed versus the depth of shaft for shaft concrete placement;
   vii. time limits for concrete placement with references cited used in determination; and
   viii. the method to form a horizontal construction joint during concrete placement.

l. When applicable, include a description of the material to temporarily backfill a drilled shaft excavation hole during a stoppage of the excavation operation, as well as the method to place and remove the material.

m. Details of procedures to prevent loss of slurry or concrete into waterways, sewers, and other areas in accordance with the contract.

n. Method and materials 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.

o. Details of required load tests including equipment, instrumentation, procedures, calibration data for test equipment, calculations, and drawings.

p. Details and procedures for protecting existing structures, utilities, roadways, and other facilities during drilled shaft installation.

q. Include measures to prevent excessive caving of the drilled shaft excavation and monitoring and controlling the vibrations from the drilled shaft installation.

2. The engineer will evaluate the drilled shaft installation plan for conformance with the contract. Schedule a shaft installation plan submittal meeting, following review of the contractor's initial submittal of the plan. The following people must attend the shaft installation plan submittal meeting:

a. The superintendent, on-site supervisors, and other contractor personnel involved in preparing and executing 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 the Department's personnel who will provide inspection and oversight during the drilled shaft construction phase of the project.

3. Submit any proposed updates or modifications to the drilled shaft installation plan to the engineer. The engineer will evaluate the new information for conformance with the contract within 14 calendar days after receipt of the submission.

D. Slurry Technical Assistance.

1. When using slurry to construct drilled shafts, provide, or arrange for, technical assistance from the slurry manufacturer as specified in Section 606.3.5.E. Submit the following to the engineer:

a. The name and phone number of the slurry manufacturer's technical representative assigned to the project.

b. The names of the contractor’s personnel assigned to the project and trained by the slurry manufacturer’s technical representative in the proper use of slurry. In the submittal, include a signed training certification letter from the slurry manufacturer for each individual, including the training dates.

E. Drilled Shaft Preconstruction Conference.

1. Hold a drilled shaft preconstruction conference at least 5 calendar days before the contractor begins shaft construction work. Discuss boring information, construction procedures, personnel, equipment, and other elements of the accepted shaft installation plan as specified in Section 606.3.1.C. Discuss the frequency of scheduled site visits by the slurry manufacturer’s representative. The following people must attend:

a. The superintendent.

b. On-site supervisors.

c. Key personnel in charge of excavating the shaft; placing the casing; placing slurry; placing the steel reinforcing bars; and placing the concrete.

d. The slurry manufacturer's representative.

e. The project engineer.

f. Inspection personnel.

2. If the contractor's key personnel change, or if the contractor proposes a significant revision of the approved drilled shaft installation plan, the engineer may request an additional drilled shaft preconstruction conference before performance of additional shaft construction operations.

F. Shaft Construction Logs.

1. Prepare inspection logs documenting each shaft construction activity, including casing installation, excavation, shaft bottom inspection, reinforcement installation, and concrete placement. Document the work performed with frequent reference to the date, time, and casing or excavation elevation in the logs. Prepare and submit the logs documenting subsurface investigation borings or rock core holes performed for the contract at drilled shaft foundation locations.

2. Include the following information in the temporary and permanent casings records:

a. Identification number and shaft location;

b. diameter and casing wall thickness;

c. casing reinforcement dimensions;

d. top and bottom casing elevations;

e. casing installation method and equipment;

f. problems encountered during casing installation; and

g. name of inspector and the date, time, and name of any inspector changes.

3. In the shaft excavation log, include at least the following information:

a. Shaft identification number, location, and surface elevation;

b. description and approximate top and bottom elevation of each soil or rock material encountered;

c. seepage or groundwater conditions;

d. type and dimensions of tools and equipment used and any changes to the tools and equipment;

e. type of drilling fluid used and results of slurry tests;

f. problems encountered;

g. elevation of changes in the shaft diameter;

h. method used for bottom cleaning;

i. final bottom elevation of the shaft; and

j. name of the inspector and the date, time, and name of any inspector changes.

4. Include at least the following information in the concrete placement records:

a. Concrete mix used;

b. start and end times for concrete placement;

c. volume and start and end time for each truck load of concrete placed;

d. concrete test results;

e. concrete surface elevation and corresponding tremie tip elevation periodically during concrete placement;

f. concrete yield curve consisting of volume versus concrete elevation, actual, and theoretical; and

g. name of the inspector and the date, time, and name of any change of inspector personnel.

5. Submit the logs for each shaft construction activity to the engineer within 24-hours of completing the activity. Submit a full set of shaft inspection logs for an individually drilled shaft to the engineer within 48-hours of completing shaft concrete placement.

G. Exploratory Drilling Plan

1. Submit an exploratory drilling plan for the engineer's approval before drilling.

a. All drilling apparatus must be of sufficient size and capacity to carry on drilling operations in an efficient manner and provide holes of adequate size. The minimum diameter of the hole must be 3-inches into the bedrock.

606.3.2 Drilled Shaft Excavation.

A. When installing drilled shafts in conjunction with embankment construction, place the embankment fill first unless otherwise shown in the contract, or approved by the engineer.

B. Excavate to the foundation cap elevation before beginning the drilled shaft, unless otherwise noted in the contract, or approved by the engineer.

C. Once excavation begins, excavate in a continuous operation until completion, except for interruptions and stops as noted below:

1. Interrupt excavation operation only for casing splicing and obstruction removal. The Department will consider interruptions for anything other than these reasons as stops.

2. Excavation may stop if it is not possible to complete the drilled shaft by the end of the shift, or series of continuous shifts, provided that the contractor protects the shaft as indicated in Section 606.3.4.

3. When using slurry in shaft excavation and work stops, maintain a minimum level of drilling slurry in accordance with Section 606.3.5.E. Recondition the slurry to the required slurry properties in accordance with Section 606.2.D before restarting shaft excavation.

D. The Department will allow drilled shaft excavation without excavation protection, provided the contractor can demonstrate stability of the soil or rock above the water table and zones of seepage.

E. For excavation below the casing, perform sidewall over-reaming when the engineer determines that the sidewall of the hole has softened due to excavation methods, has swelled due to delays in the start of concrete placement, or has degraded because of slurry cake buildup. Over-ream a minimum of 1/2-inch deep and a maximum of 3 inches deep. Over-ream with a grooving tool, over-reaming bucket, or other equipment approved by the engineer.

F. Repair disturbances to the foundation cap area caused by shaft installation before placing the cap concrete.

G. Control operations to prevent damage to existing structures, utilities, roadways, and other facilities in accordance with the drilled shaft installation plan.

606.3.3 Obstructions.

Notify the engineer promptly when encountering obstructions during drilling. The Department considers specific objects as obstructions including boulders, logs, and man-made objects encountered during shaft drilling that prevent or hinder drilling. When efforts to advance past the obstruction result in the significant reduction of progress, compared to progress made in drilling through the geological formation that contains the obstruction, remove, bypass, or break up the obstruction as force account work.

606.3.4 Drilled Shaft Excavation Protection.

A. Do not leave drilled shaft excavations open overnight or during stops unless the casing is full depth or the shaft is otherwise protected against sidewall instability. The Department defines an open excavation as a drilled shaft not filled with concrete or temporarily backfilled with a material approved by the engineer such as slurry, in accordance with Section 606.3.1.C, or protected in accordance with Section 606.3.5.

B. The Department will not require casing of drilled shafts in stable rock formations during stoppages unless required by the contract or specified here.

606.3.5 Drilled Shaft Excavation Protection Methods.

A. Protect the walls and bottom of the drilled shaft excavation to prevent side wall caving and bottom heave and to avoid disturbance of the soil adjacent to the drilled shaft. Acceptable protection methods include the use of a casing, drilling slurry, or both.

B. Temporary Casing Construction Method.

1. In stable soils, conduct casing installation and removal operations, and drilled shaft excavation operations so no disturbance occurs to the adjacent soil outside the casing for the full height of the drilled shaft. The Department defines disturbed soil as soil with geotechnical properties that have changed from the in-situ soil properties and the changes adversely affect the performance of the drilled shaft foundation.

2. The Department will allow excavation in soils below the water table with use of a sealed casing in competent soils to prevent water from entering the excavation, provided the water level within the casing does not rise or exhibit flow.

3. During withdrawal of the temporary casing, maintain a sufficient head of fluid concrete to ensure that water or slurry outside the temporary casing does not breach the column of freshly placed concrete.

4. Extract the casing by pulling in-line with the shaft axis. Avoid excessive rotation of the casing to limit deformation of the reinforcing steel cage.

5. Remove temporary casings from the excavation after completing concrete placement, unless the engineer approves of leaving the casings in place.

C. Permanent Casing Construction Method.

Install permanent casings using driving methods except when rotating, oscillating, or vibrating methods are specified in the contract and the approved drilled shaft installation plan.

D. Drilled Shafts Above Grade.

When the shaft extends above ground or through a body of water, the contractor may form that portion with a removable formwork except when specified for permanent casing. Strip the removable formwork from the shaft in a manner that does not damage the concrete in accordance with Sections 604 and 610.3.7. Do not expose the shaft concrete to saltwater or moving water in accordance with Table 610.3-4.

E. Slurry.

1. Use slurry in accordance with Section 606.2.D, to maintain a stable excavation during excavation and concrete placement operations when:
   a. Water begins to enter the drilled shaft excavation at a rate of greater than 12 inches per hour;
   b. it becomes impossible to restrict the amount of water in the drilled shaft to less than 3-inches before concrete placement; or
   c. water pressure needs equalizing on the sides and base of the drilled shaft excavation when encountering or anticipating groundwater based on the available subsurface data.
2. Slurry Sampling and Testing.
   a. Mix and 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 and in accordance with Section 606.3.1.C. Provide samples taken at mid-height and within 2-feet of the bottom of the storage area.
   b. Sample and test slurry in the engineer's presence, unless otherwise approved by the engineer. Record the date, time, names of the persons sampling and testing the slurry, and the test results. 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.
   c. Take and test slurry samples during drilling to verify control of slurry properties. At a minimum, take and test the sample sets of slurry at least once every 4-hours after beginning use during each shift.
   d. Take and test sample sets of slurry immediately before placing concrete.
3. Slurry Technical Assistance.
   a. When using slurry, the manufacturer's representative, as identified to the engineer in accordance with Section 606.3.1.D, must:
      i. Provide technical assistance for use of the slurry.
      ii. Be present at the site before placing slurry in a drilled hole.
      iii. Remain at the site during construction and completion of a minimum of 1 drilled shaft to adjust the slurry mix to the specific site conditions.
   b. When the manufacturer's representative leaves the site, provide an employee trained in the use of the slurry, as identified to the engineer in accordance with Section 606.3.1.D. Ensure

that the employee is present at the site throughout the remainder of shaft slurry operations performing the duties specified above.

4. Minimum Level of Slurry in the Excavation.
   a. Maintain the slurry level at a height required to provide and maintain a stable hole, but no less than 5-feet above the water table or surface of surrounding body of water, if at an offshore location.
   b. Provide casing, or other means, as necessary to meet these requirements.
   c. Maintain the slurry level above all unstable zones at a sufficient distance to prevent bottom heave, caving, or sloughing of those zones.
      i. Throughout all stops in drilled shaft excavation operations, monitor and maintain the slurry level in the excavation so that it is no lower than the water level elevation outside the drilled shaft or the elevation required to provide and maintain a stable hole.
5. Cleaning Slurry
   a. Clean, re-circulate, de-sand, or replace the slurry, as needed, to maintain the required properties. Ensure that sand content is within the specified limits immediately before concrete placement.

606.3.6 Drilled Shaft Excavation Inspection.

A. Clean the bottom of the excavations of drilled shafts. The Department will not allow more than 3-inches of sediment or loose or disturbed material at the bottom of the drilled shaft excavation, in soil shafts, or more than 1/2-inch for 50 percent of the shaft bottom area in rock sockets before placing concrete. Refer to Section 606.3.10 for allowable sidewall tolerances.

B. To determine that the drilled shaft bottom and sidewalls are in accordance with the contract, inspect the bottom and sidewalls of the 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. Do not continue with drilled shaft construction until receiving an approval from the engineer.

C. If the engineer determines that stable conditions do not exist, immediately 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 repair of the instability, in accordance with the specifications, and until receiving the engineer's approval of the revised drilled shaft installation plan.

606.3.7 Rock Sockets.

The Department considers rock sockets as drilled shafts in rock. Construct rock sockets in accordance with the contract. For the Department to consider excavated material as rock, the material must qualify as geomaterial having an unconfined compressive strength equal to or greater than 725-PSI that conventional earth augers or under reaming tools cannot drill requiring use of rock augers, core barrels, air tools, and other excavation methods.

606.3.8 Reinforcing Steel Assembly and Placement.

A. Fabricate and handle the steel reinforcing cage in accordance with Section 611.

B. Brace the steel reinforcing cage to retain its configuration during handling and construction. Tie intersections of vertical and horizontal bars.

C. Position and fasten the steel reinforcement to provide the minimum clearances in accordance with the contract to ensure no displacement of the steel reinforcing cage occurs during concrete placement.

D. 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.

E. Do not splice the steel reinforcement cage during placement in the shaft excavation, unless otherwise shown in the contract or approved by the engineer.

F. If the engineer allows splicing of the steel reinforcing cage during placement in the drilled shaft, ensure that the splice details and location of the splices are in accordance with the contract and the approved drilled shaft installation plan.

G. Hold the steel reinforcing cage in position throughout the concrete placement operation. Support the reinforcing steel in the drilled shaft so that the location of the reinforcing steel will remain within allowable tolerances in accordance with Section 606.3.10. Use concrete spacers or other approved non-corrosive spacing devices near the bottom and the top and at intervals not exceeding 10-feet vertically. Provide 1 spacer per foot of excavation diameter with a minimum of 4 spacers in each group of spacers. Use spacers to ensure concentric spacing between the outside of the steel reinforcing cage and the side of the excavation along the entire length of the drilled shaft. Provide bottom supports made of plastic, or concrete to ensure that the bottom of the cage remains at the proper distance above the bottom of the excavation, unless the cage is suspended above the base during the concrete pour.

H. Remove bracing steel that may constrict the interior of the reinforcing cage after lifting the cage.

I. Check the top elevation of the steel reinforcing cage before and after concrete placement. If the location of steel reinforcing cage is outside the tolerances specified in Section 606.3.10, the Department will consider the result a defective drilled shaft. Make corrections to the engineer's satisfaction. Do not construct additional drilled shafts until after making modifications of the steel reinforcing cage support that satisfy the engineer.

606.3.9 Concrete Placement, Curing, and Protection.

A. Begin concrete placement as soon as possible after completing the drilled shaft excavation and approval by the engineer. Continue the concrete placement in 1 operation to the top of the drilled shaft, or as shown in the contract. Cure exposed drilled shaft surfaces in accordance with Section 501.3 with materials in accordance with Section 1022.6.

B. Use only the 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 so the concrete remains in a workable plastic state throughout placement.

C. Before concrete placement, provide test results of both a trial mix and a slump loss test, conducted by an approved testing laboratory to demonstrate that the concrete meets the defined placement time limit. Conduct the trial mix and slump loss tests at ambient temperatures appropriate for site conditions.

D. Place concrete continuously until completing the work, resulting in a seamless, uniform shaft.

1. Place the concrete by tremie methods in accordance with Section 610.3.4.D.2.

2. Adhere to the time limit for concrete placement, as defined in the approved drilled shaft installation plan, and demonstrated by a successful technique shaft. Start concrete placement time at the mixing of concrete and extend through to the completion of placement in the drilled shaft excavation, including time for removing temporary casings.
3. Place concrete when the ambient air temperature matches ambient air temperature that existed during the concrete trial tests and slump loss tests.

E. Complete a concrete yield plot for each shaft. Submit a yield plot to the Department within 24-hours of completing the concrete pour.

F. Do not perform casing installation or drilled shaft excavation operations within a distance of 3 diameters of a newly poured drilled shaft within 24-hours of concrete placement in the newly poured drilled shaft or before the concrete in the newly poured drilled shaft reaches a minimum compressive strength of 1,800-PSI.

606.3.10 Drilled Shaft Construction Tolerances.

A. Construct 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 as shown in Table 606.3-2:

Table 606.3-2. Horizontal Tolerances for Drilled Shafts

Drilled Shaft Diameter	Tolerance
Greater than 24 inches and less than 60 inches	4 inches
60 inches or larger	6 inches

B. The tolerance for drilled shafts in soil is within 1.5 percent of plumb. The tolerance for drilled shafts in rock is within 2 percent of plumb. Measure plumb from the top of the poured drilled shaft elevation, or mudline, whichever is lower.

C. During drilling or excavation, make frequent checks on plumb, alignment, and dimensions of the drilled shaft. Submit a procedure for correcting deviations exceeding the allowable tolerances. Correct deviations in accordance with the approved procedure.

D. Ensure that drilled shaft steel reinforcing bars do not extend 6 inches above, or 3-inches below, the elevation shown in the contract.

E. The shape of the reinforcing cage must share concentric properties with the drilled shaft excavation, within a tolerance of 1 1/2-inches.

F. Ensure that the top elevation of the completed drilled shaft is within a tolerance of plus 1-inch or minus 3-inches.

G. Match the drilled shaft diameter to the diameter shown in the contract.

H. Ensure that tolerances for casings are in accordance with the ASTM designation in Section 606.2.C unless otherwise noted in the contract.

I. The Department will consider drilled shaft excavations and completed drilled shafts not meeting the specified tolerances as defective. Correct defective drilled shafts to the satisfaction of the

engineer. Submit redesign drawings and computations for correcting the defects, signed by a professional engineer in the State of Delaware.

606.3.11 Non-Destructive Testing.

A. For bridges, perform Thermal Integrity Profiling (TIP), Method B and Crosshole Sonic Log (CSL) testing on all drilled shafts in accordance with ASTM D7949 and ASTM D6760. For all other structures, perform either TIP or CSL testing at the contractor's discretion on all drilled shafts in accordance with ASTM D7949 or ASTM D6760.

B. For TIP, Method B, attach thermal wire cables to the longitudinal reinforcement of the shaft using nylon zip-ties at 1 1/2 to 2-inches from the top and bottom of each node. Provide and install 1 thermal wire cable for each foot of drilled shaft diameter, rounded to the nearest whole number, unless otherwise shown in the contract. Place a minimum of 3 thermal wire cables for each shaft. Attach each thermal wire cable to a data logger with the data logger suspended on a protruding rebar well above the top of the concrete. If the cable is routed with a bend at any location, take extra precautions on securing the cable with zip-ties on either side of each such node.

1. Connect thermal wire cables to a data logger immediately following casting of concrete. Make note of which cable is connected to which data logger. The data logger will collect data at 15-minute intervals for 24-hours or for a duration approved by the engineer. In the event peak temperature is not reached within the specified time period, the data logger units will remain connected to the thermal wire cables for a longer duration as directed by the engineer. After completion of the data collection period, connect the data logger to the main TIP data acquisition unit and download the data files for analysis of temperatures versus depth.
2. Immediately report to the engineer any potential local defects indicated by locally low temperatures relative to the average temperature at that depth, or average temperatures significantly lower than the average temperatures at other depths.
3. Submit a report of the TIP testing results and analysis to the engineer within 7 calendar days of testing completion. The report shall include:
   a. Graphical displays of all temperature measurements versus depth.
   b. Indication of unusual temperatures, particularly of significantly cooler local deviations of the average at any depth from the overall average over the entire length.
   c. The overall average temperature. This temperature is proportional to the average radius computed from the actual total concrete volume installed assuming a consistent concrete mix throughout. The temperature at that point compared to the overall average temperature can determine the radius at any point.
   d. Variations in temperature between thermal wire cables at each depth, which in turn correspond to variations in cage alignment. Where concrete volume is known, note the cage alignment or offset from center.

C. Accommodate the CSL testing by providing and installing access tubes.

1. Install access tubes for cross-hole sonic log testing in all drilled shafts, except as otherwise noted, to allow access for the CSL 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 allow cancellation of the testing.

2. Attach access tubes to the interior of the reinforcement cage. Provide and install 1 access tube for each foot of drilled shaft diameter, rounded to the nearest whole number, unless otherwise shown in the contract. Place a minimum of 3 tubes. Place the access tubes around the drilled shaft, inside the spiral or hoop reinforcement, and 3-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 do not occur, due to close spacing of the vertical reinforcement, bundle the access tubes with the vertical reinforcement.
3. If required to trim the cage, and access tubes for CSL testing are attached to the cage, shift the access tubes up the cage or cut the access tubes. Provide watertight caps for the cut tube ends.
4. Install access tubes in a 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 2-feet above the top of the drilled shaft. Splice joints in the access tubes, if required, to achieve full-length access tubes. Ensure a watertight fit. Clear the access tubes of debris and extraneous materials before installing.
5. Fill the access tubes with potable water, before concrete placement, and install watertight, threaded caps.
6. Before performing CSL testing operations, remove the concrete at the top of the drilled shaft down to sound concrete.
7. After placing the drilled shaft concrete, and before beginning the CSL testing of a drilled shaft, inspect the access tubes and replace tubes a test probe cannot pass through. To replace a tube, core a 2-inch diameter hole through the concrete for the entire length of the shaft. Unless directed otherwise by the engineer, locate the cored holes approximately 6-inches inside the reinforcement. Log descriptions of inclusions and voids in cored holes and submit a copy of the log to the engineer. Preserve findings from cored holes, identified by location, and make available for inspection by the engineer.
8. Perform testing at least 96-hours after the drilled shaft concrete has cured. Allow additional curing time before testing if the drilled shaft concrete contains admixtures, such as a set retarding admixture or a water-reducing admixture.

D. The engineer will determine final acceptance of each drilled shaft based on the required non-destructive testing results and analysis for the tested shafts and a review of the visual inspection reports for the subject drilled shaft. The engineer will provide a response to the contractor within 5 calendar days after receiving the test results and analysis submittal.

1. If the contract does not require technique shafts, the engineer may approve continuing with other drilled shafts before approval and acceptance of the first production shaft if:
   a. The engineer observes that construction of the first production shaft was satisfactory.
   b. The contractor placed the first production shaft in accordance with the drilled shaft installation plan.
   c. A review of contractor's daily reports and inspector's daily logs concerning excavation, reinforcing steel placement, and concrete placement caused no concerns.
2. If the engineer determines that concrete placed under slurry for a given drilled shaft is structurally inadequate, the engineer will reject the drilled shaft. The engineer will not allow further placement of concrete under slurry until the contractor submits written changes to the

construction methods to prevent future structural inadequacies. Obtain the engineer's written approval of the submittal before beginning additional drilled shafts.

3. Based on the test results, the engineer may determine that additional investigation of a completed drilled shaft is necessary. The contractor may also request additional testing. At the engineer's request, core a hole as determined from non-destructive testing and analysis, to explore the drilled shaft condition.

   a. Before beginning coring, submit the method and equipment used to drill and remove cores from drilled shaft concrete to the engineer. Do not begin coring until receipt of the engineer's written approval.

   b. The engineer will determine the number, locations, diameter, and depth of the core holes, and lengths of individual core runs. Ensure that coring procedures minimize abrasion and erosion of the core samples and 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. Recover the complete core. Preserve the recovered core in labeled wood core boxes, identified by location and depth, and make available for inspection by the engineer. The engineer may direct water-pressure testing in the core holes, or unconfined compression testing and other laboratory testing on selected samples from the concrete core.

4. If the additional testing indicates that the drilled shaft has no defects, the Department will take responsibility for the testing and delay costs. If the drilled shaft construction is on the critical path of the contractor's schedule, the Department will grant a time extension equal to the delay created by the additional testing.

5. For all unacceptable drilled shafts, submit a plan for further investigation or remedial action to the engineer for approval. Calculations and working drawings must support all modifications to the drilled shaft dimensions required by the investigation and the remedial action plan. Use a registered engineer in the State of Delaware to prepare the investigation and remedial correction procedures and designs and submit to the engineer for approval. Do not begin repair operations until receipt of the engineer's written approval of the investigation and remedial action plan.

E. Dewater access tubes and cored holes and fill with grout after completion of tests and acceptance of the drilled shaft. 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.

F. The contract may specify alternative non-destructive tests such as gamma-gamma, sonic echo/impulse response (ASTM D5882), or other tests the engineer may direct the contractor to use alongside, or instead of, TIP or CSL testing. Comply with all requirements for the alternate test methods, in accordance with the contract.

606.3.12 Technique Shafts.

A. Demonstrate the adequacy of the methods, techniques, and equipment by successfully constructing a technique shaft or shafts in accordance with the contract. Position the technique shafts at the locations shown in the contract, or as directed by the engineer, but no less than a distance of 3 drilled shaft diameters from the closest production shaft. Drill the technique shafts to the maximum diameter and maximum depth of any production drilled shaft shown in the contract. Reinforce the technique shafts with the same reinforcement as the corresponding size production shaft, and include TIP thermal wire cables, CSL access tubes, and load testing devices as specified in the contract.

B. Obtain the engineer's acceptance of the completed technique shafts before installing production drilled shafts. Failure to demonstrate the adequacy of its methods and equipment may result in the engineer requiring the contractor to submit a plan to modify its methods and equipment to eliminate unsatisfactory results.

C. Once the engineer approves construction of production drilled shafts, make no changes in the methods or equipment used to construct the technique shaft without the engineer's written approval.

D. The engineer will use the technique shafts to determine the contractor's ability to:

1. Control dimensions and alignment of excavations within tolerance;
2. install and remove temporary casings;
3. control the size of the excavation under caving conditions;
4. clean the completed drilled shaft excavation;
5. construct drilled shafts in open water areas;
6. handle and place reinforcing cages;
7. place concrete meeting the specification requirements within the prescribed time limit;
8. perform non-destructive and load testing; and
9. execute other necessary construction operations.

E. When authorized in writing by the engineer, cut off the technique shafts no less than 2-feet below finished grade and leave in place. Restore the disturbed areas at the sites of the technique shafts as nearly as practical to the original condition.

606.3.13 Drilled Shaft Load Tests.

A. Perform load tests on technique or production shafts at the locations shown in the contract unless otherwise directed or approved by the engineer.

B. If the equipment or procedures change following completion of load testing, conduct additional load tests as directed by the engineer on a replacement technique or production shaft.

C. Complete load testing and have the results evaluated by the engineer before placing production drilled shafts, unless otherwise authorized by the engineer.

1. Perform static load tests in accordance with ASTM D1143.
2. Perform force pulse (rapid) load tests in accordance with ASTM D7383.
3. For bi-directional load cell testing, install load cells and load test instrumentation in accordance with the bi-directional load cell supplier recommendations. Ensure that the bi-directional load cells are capable of expanding to no less than 6 inches while maintaining the applied test load.
   a. Coordinate with the load cell supplier to determine required equipment, materials, quantities, procedures, and all other applicable items needed to complete the load testing shown in the contract.
   b. Provide a pressurized gas source, a hydraulic pump, hydraulic lines, calibrated hydraulic gauge, and other equipment and material necessary to perform the load tests. Provide

potable water from an approved source to form the hydraulic fluid used to pressurize the bi-directional load cells.

c. Provide, install, and monitor vibrating wire strain gauges as shown in the contract. Place the strain gauges in pairs on opposite sides of the reinforcing cage at the elevations shown in the contract, unless otherwise directed by the engineer.

d. Attach 2 Linear Variable Differential Transformers (LVDT) vibrating wire displacement gauges to each load cell to monitor the load cell expansion and contraction. Mount 2 LVDT gauges on an independent reference beam and set on opposite sides of the top of the load tested shaft to monitor axial shaft displacement.

e. Set 2 telltale rods on the top of each load cell to monitor displacement of the top of the load cell. Provide a telltale consisting of a 3/8-inch diameter stainless steel greased rod placed inside a constant 3/4-inch diameter pipe. Individual sections of telltales will have joint-coupled flush so that each rod is of uniform diameter throughout its length.

f. Provide a portable computer and electronic logging equipment to simultaneously monitor all instrumentation at time intervals designated by the engineer.

g. 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 here.

h. Mandatory guidelines:

   i. Weld steel top and bottom bearing plates to the load cells in accordance with Section 615. Provide holes through the bearing plates to facilitate placement of tremie concrete.

   ii. Coat the upper surface of the bottom steel bearing plate with grease before installing in the shaft to prevent concrete bonding with the bottom plate.

   iii. Attach the load cells and plate assembly to the reinforcement cage. Fasten all hydraulic hoses, telltale casing, and slip joints to the rebar cage. Before installing in the drilled shaft excavation, protect the top of any piping to keep dirt, concrete, or other materials from entering the piping.

   iv. Limit cage deflection to a maximum of 2-feet between pick points while lifting the cage from the horizontal position to vertical. Provide support to maintain deflection within the specified tolerance.

i. For each load test, place the load on the drilled shaft in increments of 5 percent of the estimated maximum test load shown in the contract, or until the nominal resistance load occurs, indicated by the instruments, or to the maximum capacity of the load cell, whichever occurs first. Unless the maximum capacity of the load cell occurs, apply increments of 2.5 percent of the estimated maximum test load until attaining the limiting load or the drilled shaft top displacement reaches 2-inches, or to the maximum extension of the load cell. When using the load cell 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, with maximum of 15-minutes, and take the instrument system readings immediately. The engineer may elect to hold the maximum applied load for up to 1-hour.

j. 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. Complete removal of a load decrement and the completion time frame of the instrument readings within 5 to 15 minutes. The engineer may also require a reloading cycle with 10 loading increments and 5 unloading decrements. Record the final recovery of the drilled shaft for a period up to 1-hour after the last unload interval.

k. Submit a preliminary test report containing the load displacement curves, and other test data within 5 calendar days of completing each load test. Submit the final report on the load tests within 14 calendar days after completing each load test. Include at least the following items in the test report:

i. Shaft identification number and location;

ii. Testing dates;

iii. Description of the shaft details, instrumentation, and test procedures;

iv. Tables presenting all instrumentation data;

v. Plots of load versus displacement, up and down, for each load cell level, for each stage of the test;

vi. Plots of load along the length of the drilled shaft determined from the strain gauge data for at least ten applied load increments;

vii. Summary of unit side resistance along the length of the drilled shaft and end bearing resistance;

viii. Plots of creep displacement for each load increment; and

ix. Plot of equivalent top-of-shaft displacement for the load tested shaft, developed from the load test data.

l. After completing the load test to the engineer's satisfaction, 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 all voids remaining outside the load cells after completing the load test.

606.3.14 Exploratory Drilling.

A. Confirm the top of rock elevation and characterize the approximate rock quality designation of the drilled bedrock.

B. Drill at locations in accordance with the contract or as specified by the engineer.

C. Perform air track drilling in the presence of the engineer using drilling apparatus in the exploratory drilling plan. Advance the hole through the overburden without sampling.

D. Ensure that the drilled hole is vertically plumb and open throughout drilling operations. Support the hole as necessary with casings advanced by driving or jacking. Seat the casing tightly in the bedrock. The casing is temporary and may be withdrawn or left in place before grouting.

E. Notify the engineer if drilling encounters unique subsurface features such as soft zones, soil seams, or voids. Drill a minimum of 10 feet of continuous rock below the top of bedrock or bottom of shallow or deep foundation in the footprint of the exploratory drilling location, whichever is deeper.

F. Grout the drilled holes to the top of the drilled elevation. Use grout materials in accordance with DNREC's 7301 Regulations Governing the Construction and Use of Wells, Section 5.8.12.1. Do not begin grouting the drilled holes until completing drilling of all locations.

G. Submit an exploratory drilling log for each location within 48 hours of completing the final drilled hole. Include the following in the logs:

1. Depth of the overburden and rock penetrated;
2. methods used to advance the hole;
3. methods used to advance the casings;
4. length of casings installed;
5. location and depth of any unique subsurface features;
6. depths of loss of air pressure with its associated elevation;
7. tabulation of time per foot of penetration for the full drilled depth; and
8. approximate rock quality designation

606.4 Method of Measurement.

A. The Department will measure:

1. Drilled shafts in soil by the length in linear feet from the plan top of shaft in soil elevation to the final bottom of shaft in soil elevation. The Department will not separately measure excavation, blasting, slurry, reinforcing steel, concrete, grout, or non-destructive testing.
2. Technique shafts by the length in linear feet from the existing ground surface elevation at the center of the technique shaft hole before drilling to the authorized bottom elevation of the hole. The Department will not separately measure excavation, blasting, slurry, reinforcing steel, concrete, grout, or non-destructive testing.
3. Permanent casing by the length in linear feet of each size casing provided and installed.
4. Drilled shafts in rock by the length in linear feet from the top of rock elevation to the final bottom of shaft in rock elevation. The Department will not separately measure excavation, blasting, slurry, reinforcing steel, concrete, grout, or non-destructive testing.
5. 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.
6. Exploratory drilling by the length in linear feet from the ground elevation where the drilling begins to the bottom of the exploration hole. The Department will not separately measure grout or temporary casings to maintain an open bore hole.

606.5 Basis of Payment.

A. Payment includes full compensation for excavation of soil and rock, blasting, slurry, reinforcing steel, concrete, concrete curing, grout, non-destructive testing, and all other required Work.

B. Payment includes full compensation for providing and placing the permanent casing.

C. Payment includes full compensation for performance of the load test and for reporting of procedures and results.

D. Payment includes full compensation for exploratory drilling and for grout, temporary casings, and results.

E. The Department will pay for efforts to advance past an obstruction that results in the significant reduction of progress, compared to progress made in drilling through the geological formation that contains the obstruction, and the work to remove, bypass, or break up an obstruction using the Force Account provisions in Section 109.

ITEM	DESCRIPTION	UNIT
606000	DRILLED SHAFT IN SOIL, 30" DIAMETER	LF
606001	DRILLED SHAFT IN SOIL, 36" DIAMETER	LF
606002	DRILLED SHAFT IN SOIL, 42" DIAMETER	LF
606003	DRILLED SHAFT IN SOIL, 48" DIAMETER	LF
606004	DRILLED SHAFT IN SOIL, 60" DIAMETER	LF
606005	DRILLED SHAFT IN SOIL, 72" DIAMETER	LF
606006	DRILLED SHAFT IN SOIL, 54” DIAMETER	LF
606007	DRILLED SHAFT IN SOIL, 66” DIAMETER	LF
606010	TECHNIQUE SHAFT, 30" DIAMETER	LF
606011	TECHNIQUE SHAFT, 36" DIAMETER	LF
606012	TECHNIQUE SHAFT, 42" DIAMETER	LF
606013	TECHNIQUE SHAFT, 48" DIAMETER	LF
606014	TECHNIQUE SHAFT, 60" DIAMETER	LF
606015	TECHNIQUE SHAFT, 54" DIAMETER	LF
606016	TECHNIQUE SHAFT, 66” DIAMETER	LF
606017	TECHNIQUE SHAFT, 72” DIAMETER	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
606026	PERMANENT CASING FOR DRILLED SHAFT, 54” DIAMETER	LF
606027	PERMANENT CASING FOR DRILLED SHAFT, 66” DIAMETER	LF
606030	LOAD TESTING OF DRILLED SHAFTS	EACH
606031	EXPLORATORY DRILLING	LF
606040	DRILLED SHAFT IN ROCK, 24” DIAMETER	LF
606041	DRILLED SHAFT IN ROCK, 30” DIAMETER	LF
606042	DRILLED SHAFT IN ROCK, 36” DIAMETER	LF
606043	DRILLED SHAFT IN ROCK, 42” DIAMETER	LF
606044	DRILLED SHAFT IN ROCK, 48” DIAMETER	LF
606045	DRILLED SHAFT IN ROCK, 54” DIAMETER	LF
606046	DRILLED SHAFT IN ROCK, 60” DIAMETER	LF
606047	DRILLED SHAFT IN ROCK, 66” DIAMETER	LF

SECTION 607 — EARTH RETAINING WALL SYSTEMS

607.1 Description.

This work consists of designing, fabricating, providing, and placing MSE walls and modular block retaining walls.

607.2 Materials.

A.	Modular Block Walls	Section 1040
B.	MSE Walls	Section 1048

607.3 Construction.

607.3.1 Submittals.

A. Design the 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. The engineer will take responsibility for external stability. The wall system designer shall take responsibility for all other limit states in the design for the selected wall system.

B. Provide design calculations and a complete set of working drawings, in accordance with Section 105.4, before beginning fabrication. Have a registered State of Delaware professional engineer seal the calculations and drawings and obtain the engineer's approval before fabrication. Include the following information in the submittal:

1. Earthwork requirements, including specifications for material and compaction of backfill.
2. Details of revisions or additions to drainage systems or other facilities required to accommodate the system.
3. Details of barriers or railings connected to the wall.
4. 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.
5. Complete design calculations substantiating that proposed designs satisfy the design parameters in the contract.
6. Complete details of all elements required for proper construction of the retaining wall system, including complete material specifications.
7. Complete list of materials.
8. For modular block walls, include the following:
   a. Length, location, and type of wall.
   b. Step-by-step process for constructing the wall.
9. Provide the engineer with a certificate of compliance certifying that the provided materials comply with the applicable contract specifications. Provide the engineer with a copy of all test results performed by the contractor or his supplier necessary to assure contract compliance.

607.3.2 Excavation and Backfill.

A. Excavate to the elevations shown in the contract in accordance with Section 207. Ensure the work area remains dry in accordance with Section 906.

B. 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.

C. Compact the foundation as outlined in the contract before wall construction. Remove and replace any foundation soils found unsuitable, as directed by the engineer.

D. Simultaneously construct the surrounding earth embankment and compact in lifts at the same elevation as the MSE wall backfill placement, meeting density requirements in accordance with the contract.

607.3.3 Leveling pad.

A. At each panel foundation level, provide an unreinforced concrete leveling pad as shown in the contract. Cure the leveling pad a minimum of 12-hours with materials in accordance with Section 1022.6 before placement of wall panels. The concrete finish will contain a smooth and flat surface, and not vary from the design elevation, as shown in the contract.

B. For modular block walls, construct the foundation element with either a leveling pad or footer, in accordance with the manufacturer's instructions.

607.3.4 Wall erection.

A. Place precast concrete panels, constructed in accordance with Section 1048. Handle panels with lifting devices 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. When placing backfill material behind the panels, maintain the panels in vertical position by means of temporary wooden wedges placed in the joint at the junction of the 2 adjacent panels on the external side of the wall. Use external bracing for the initial lift.

B. Meet the following tolerances:

1. Do not exceed vertical plumb tolerances and horizontal alignment tolerances of more than 3/4-inch when measured along a 10-foot straight edge.
2. The maximum allowable offset between precast components is 3/4-inch.
3. Do not exceed the overall vertical plumb tolerance from top to bottom of 1/2-inch per 10-feet of wall height.
4. Use horizontal and vertical joint widths between precast components of not less than 1/2-inch or more than 1 1/4- inches.

C. 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.

D. Install reinforcing mesh or strips after completing backfill compaction for the respective layer of soil. Place reinforcing mesh or strips perpendicular to the wall, unless otherwise shown in the contract or as directed by the engineer.

E. Grout recesses at lifting devices in tops of topmost panels flush with an approved mortar, except where the design calls for a poured concrete coping or parapet.

F. For modular block walls, construct the wall in accordance with the manufacturer's instructions.

607.3.5 Backfill Placement.

A. Place backfill to closely follow erection of each course of panels. Place No. 57 stone for at least the first 3-feet perpendicular to the back face of the panel for the full height of the wall.

B. Compact backfill to 95 percent of the maximum density as determined by AASHTO T99 Method C or D, with oversize correction, as outlined in note 7, AASHTO T99.

C. Ensure uniform distribution of the moisture content of the backfill material before and during compaction throughout each layer. Remove backfill material with moisture content outside the acceptable range and rework until the moisture content is uniformly acceptable throughout the entire lift. Determine the optimum moisture content in accordance with AASHTO T99 Method C or D (with oversize correction, as outlined in note 7, AASHTO T99).

D. The maximum compacted lift thickness is 8 inches. Decrease this lift thickness, if necessary, to obtain the specified density.

E. Achieve compaction within 3-feet of the back face of the wall facing using a lightweight mechanical tamper or hand tamp. Do not use a vibratory system within this area.

F. At the end of each day's operation, slope the last level of backfill away from the back of the wall to rapidly direct runoff of rainwater away from the wall. In addition, do not allow surface runoff from adjacent areas to enter the wall construction site.

G. For modular block walls, place and compact the backfill material in accordance with the manufacturer’s instructions.

607.4 Method of Measurement.

A. The Department will measure the quantity of MSE walls as the number of square feet of wall placed and accepted. The Department will take the vertical measurement from the top of the leveling pad to the bottom of the coping.

B. The Department will not measure MSE walls for projects with multiple walls of varying height and material.

C. The Department will measure the quantity of architectural segmental retaining walls and concrete masonry unit modular block retaining walls as the number of square feet of wall placed and accepted. The Department will take the vertical measurement from the top of the leveling pad or footer.

607.5 Basis of Payment.

A. Price and payment for mechanically stabilized earth walls constitute full compensation for providing the design, providing and placing all materials including backfill, and performing all work required in accordance with the contract and approved design.

B. Price and payment for modular block walls constitutes full compensation for providing the design, providing all materials, and performing all work required to construct the wall system as specified.

C. The Department will pay for rock excavation in accordance with Section 202.

ITEM	DESCRIPTION	UNIT
607000	MECHANICALLY STABILIZED EARTH WALLS	SF

ITEM	DESCRIPTION	UNIT
607001	MECHANICALLY STABILIZED EARTH WALLS	LS
607011	ARCHITECTURAL SEGMENTAL RETAINING WALLS	SF
607012	CONCRETE MASONRY UNIT MODULAR BLOCK RETAINING WALLS	SF

SECTION 608 — PERMANENT SHEET PILES

608.1 Description.

This work consists of fabricating, providing, and installing steel or timber sheet piles.

608.2 Materials.

A.	Concrete Tie Back System	Section 610 and Section 1022
B.	Galvanized Steel Sheet Piles	Section 1032
C.	Timber Sheet Piles	Section 1032
D.	Galvanized Steel Hardware	Section 615 and Section 1039

608.3 Construction.

A. Do not begin installing sheet piles for a bulkhead wall until completing all muck excavation and backfilling with Borrow Type B to the elevations shown in the contract.

B. Do not jet steel sheet piles into position. The Department will allow jetting of timber sheeting, after the contractor obtains all required environmental permits. After piles are in final position and have attained full bearing, cut the tops off to a straight line at the elevation shown in the contract. 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, brace and align the tops of sheet pile walls using wales. Lap and join wales at splices and corners and bolt or fasten together. Construct wales in accordance with Sections 615 or 621.

608.4 Method of Measurement.

A. The Department will measure the quantity of steel sheet piles as the number of square feet of sheet piles place and accepted. The Department will not measure cut-off material.

B. The Department will measure the quantity of timber sheet piles as the number of thousand- feet board measure of sheet piles installed and accepted. The Department will not measure cut-off material.

C. The Department will not measure the tie-back systems.

608.5 Basis of Payment.

A. The Department will pay the quantity of steel sheet piles at the contract unit price per square foot. Price and payment will constitute full compensation for providing, placing, and cutting off the sheet piles and for steel waler construction and hardware.

B. The Department will pay the quantity of timber sheet piles at the contract unit price per square foot. Price and payment will constitute full compensation for providing, placing and cutting off the sheet piles and for timber wale construction and hardware.

C. The Department will pay the quantity of pile tie-back system at the contract lump sum price. Price and payment will constitute full compensation for providing and placing all materials.

D. The Department will pay for excavation and backfilling under the Section 207.

E. The Department will make no separate payment for pile cut-off material.

F. 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
608040	STEEL SHEET PILES, NZ 14	SF
608041	STEEL SHEET PILES, NZ 19	SF
608042	STEEL SHEET PILES, NZ 20	SF
608043	STEEL SHEET PILES, NZ 21	SF
608044	STEEL SHEET PILES, NZ 22	SF
608045	STEEL SHEET PILES, NZ 26	SF
608046	STEEL SHEET PILES, NZ 28	SF
608047	STEEL SHEET PILES, NZ 38	SF
608048	STEEL SHEET PILES, NZ 40	SF
608049	STEEL SHEET PILES, NZ 42	SF

SECTION 610 — CONCRETE STRUCTURES

610.1 Description.

This work consists of providing, placing, finishing, and curing concrete bridges, culverts, and miscellaneous structures.

610.2 Materials.

A.	Portland Cement Concrete production	Section 1022
B.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7
C.	Bar Reinforcement	Section 1037
D.	Permanent Steel Bridge Deck Forms and Supports	Section 1039
E.	Rubber Joint Sealant	Section 1042.3.B
F.	Hot Poured Joint Sealer	Section 1042.3.C
G.	Preformed Expansion Joint Fillers	Section 1042.3.D
H.	Pipe for Weep Holes	Section 1049
I.	Waterstops	Section 1049
J.	Form Oil for Concrete Formwork	Section 1049
K.	Epoxy Bonding	ASTM C881

610.3 Construction.

610.3.1 Submittals.

A. If required in the contract, submit a contractor quality control plan to verify that all materials and workmanship meet the contract requirements. 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 105.4. Upon receipt of approved quality control plans, the contractor may begin work. At a minimum, provide the following information in the plan:

1. Provide a concrete placement plan. Include detailed procedures for 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 610.3.4.

   a. Address measures necessary to ensure the quality and maintenance of the concrete in its final placement in the plan and mix design. Submit a placement plan for placing concrete by pump. At a minimum, include pump location, vertical and horizontal work reach, pump capability, placement sequence, delivery configuration, and contingency for equipment malfunction.

   b. Provide an ACI or NRMCA certified concrete flatwork technician to supervise all finishing. Provide proof of the flatwork certification to the engineer before concrete placement.

2. Temperature Control Plan.

a. Provide a hot or dry weather placement and curing plan when placing concrete in hot or dry weather. Include detailed procedures for reducing the hazards of an 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 610.3.5.A.

b. Provide a cold weather placement and curing plan when cold weather is expected or has occurred within 7 calendar days of anticipated concrete placement. Include detailed procedures for production, transporting, placing, protecting, curing, and temperature monitoring of concrete during cold weather, in accordance with the requirements of Section 610.3.5.C.

c. When the contract designates mass concrete, provide the plan to the engineer for approval in accordance with Section 105.4.

i. Use a specialty engineer registered in the State of Delaware and competent in the design and temperature control of concrete in mass elements. Include a resume for the specialty engineer, detailing relevant experience on at least 5 thermal control projects. Ensure that the specialty engineer follows 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 Sections 610.3.4.D.3 and 610.3.6.B.

ii. 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. 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 in the software used. 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.

iii. Describe methods for preventing thermal shock.

iv. Include a minimum of 1 level of redundancy for all equipment and materials to maintain a continuous pour as part of the contractor's proposal.

v. Submit the qualifications of all technicians employed to inspect or monitor mass concrete placements to the engineer. Designate an employee, approved by the specialty engineer, as qualified to inspect monitoring device installation and record temperature readings.

3. 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 Sections 610.3.4.D.4 and 610.3.6.A. Include detailed procedures for production, transporting, placing, protecting, curing, and temperature monitoring, consolidating the concrete mix in approved forms to make a dense homogeneous concrete, and contingency for equipment malfunction.

a. Submit a plan of locations and sequence of construction joints to the engineer. Include provisions and details for emergency construction joints including shear keys, bonding agents, joint sealants, waterstops, and additional reinforcement, in accordance with the requirements of Section 610.3.3.

4. Use permanent steel bridge deck forms for concrete deck slabs of bridges, when shown in the contract.
5. Provide fabrication and erection drawings for stay-in-place (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 of form support by steel beam flanges subject to tensile stresses. Have an engineer registered in the State of Delaware sign and seal these drawings and calculations.
6. Ensure that welding, welder qualifications, and prequalification of weld details and inspection of welds meet the AASHTO/AWS D1.5 Bridge Welding Code.
7. Meet the following criteria for the design of SIP 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 calculated exceeds the weight allowance for SIP metal forms and the concrete required to fill the forms shown in the contract, submit a method to modify the supporting components to support the excess weight.
   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 provided, but not to exceed 36,000-PSI.
   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 of pounds per square foot that is less than 20 plus the product of the deck thickness measured in inches multiplied by 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 the AISI Specifications for the Design of Cold Formed Steel Structural Members, latest published edition.
   f. Do not consider the permanent bridge deck form as lateral bracing for compression flanges of supporting structural members.

610.3.2 Formwork.

A. Provide falsework and forms in accordance with Section 604.

B. Where concrete pours occur over active roadways, railways, and pedestrian facilities, provide a temporary protective shield in accordance with Section 604.

C. Permanent Steel Bridge Deck Forms.

1. Install forms in accordance with approved fabrication and erection drawings. Do not rest form sheets directly on the top of steel 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 steel beam. Make all attachments for coated metal forms using bolts, clips, screws, or other approved means. 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.

2. For any permanent exposed steel with damaged galvanized coating, thoroughly clean, wire brush, and paint with 2 coats of galvanizing compound to the satisfaction of the engineer. Do not touch up minor heat discoloration in areas of welds.
3. 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 leaking through the forms is in accordance with Section 107.10. Additional shielding may be placed beneath the forms to catch leakage during the deck pour if desired.

610.3.3 Joints.

A. Construction Joints

1. Place construction joints only at locations shown in the contract and in accordance with the construction joint plan.
2. Construct 2-inch by 4-inch shear keys at vertical joints and at horizontal joints, unless stated otherwise in the contract. Leave the joint with a scored finish in accordance with Section 610.3.4.C. Bevel the forms for keys so that removal will not damage the concrete. Clean construction joints of surface laitance, curing compound, and other materials before placing fresh concrete against the surface of the joint. Use an 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.
3. Insert an approved continuous water-stop where specified in the contract. Place the water-stop no less than 3-inches from the face of the concrete. Extend the water-stop into each section of the concrete a distance of at least 2-inches or as specified in the contract.
4. Bond new concrete to existing clean concrete structures with approved bonding compound at locations identified in the construction joint plan. Apply epoxy bonding compound in accordance with manufacturer's recommendations.
5. 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.

B. Expansion and Contraction Joints.

1. Construct expansion and contraction joints to include open joints, filled joints, keyed joints, joints sealed with sealants or water-stops, and joints with combinations of these features.
2. Finish open joints in decks and sidewalks not protected by metal armor with an edging tool. Remove mortar and other debris from open joints.
3. Construct filled joints with preformed or premolded fillers unless the contract specifies polystyrene board. Use a single piece of joint filler for each joint. Anchor joint filler material to 1 side of the joint with a waterproof adhesive.
4. Provide water-stops as specified in the contract and of a type allowing joint movement without damage to the joint material. Splice, weld, or solder joints to be continuous and watertight. Prevent contamination of water-stop surfaces while embedding the water- stop in concrete. Ensure that all portions of the water-stop designed for embedment remain tightly enclosed by concrete.

610.3.4 Placing Concrete.

A. Preparation.

1. Place bar reinforcement as per Section 611. Place all other embedded accessories.
2. Set anchor bolts using a template set to the indicated elevation and alignment. Limit the threaded projection above the nut to between 3/16-inch and 1-inch.
3. Provide adequate lighting for all concrete operations conducted at night. Obtain approval of the lighting system before starting the concrete operations.
4. Prepare forms in accordance with Section 604. Remove hardened concrete and foreign matter from tools, screeds, and conveying equipment. Clean and clear all surfaces that come in contact with concrete. Moisten the forms with water before placing concrete.

B. Supply and Placing Concrete.

1. Supply concrete in accordance with Section 1022.
2. Place and consolidate the concrete mix in approved forms in accordance with the approved concrete placement plan. Place concrete continuously to prevent unplanned cold joints or damage to newly set concrete. Regulate concrete placement so that the pressures caused by the wet concrete do not exceed those used in the design of the forms. Place concrete into forms using a method that does not segregate the mix from a homogenous consistency. Deposit concrete mix as near as possible to final position.

   Discharge concrete within 5-feet of final placement point. Limit lift thickness to 2-feet. Do not exceed the capacity of the vibrators to consolidate and merge the concrete with the previous lift.
3. Use clean, watertight equipment. Do not use aluminum as the contact surface for concrete placed through any conveyance. Equip chutes on steep slopes with baffles or reverses. Do not place concrete with chute arrangements longer than 25-feet.
4. 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 discharges from the pump line. Operate the pump to produce a continuous stream of concrete without air pockets or segregation. Upon pumping completion, eject any concrete remaining in the pipeline planned to use in the work in such a manner that no contamination or separation of the concrete ingredients occurs. Provide samples of concrete for test purposes taken from the discharge end of the conduit system as close as possible to the final position of the concrete.
5. Place concrete in a manner and sequence that does not displace reinforcement. Do not harm the surface coating of the reinforcement steel. Protect protruding steel for subsequent pours. Clean any protruding steel upon completion of the pour before subsequent pours.
6. Consolidate all concrete, except underwater or other exempted placements, by mechanical vibration. Use internal vibration except for thin sections using forms designed for external vibration. Provide adequately sized vibrators to accomplish the work, with 1 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 the 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. Do not move the concrete laterally with vibrators.

C. Finishing Plastic Concrete

1. Strike off surfaces of concrete not placed against forms to the planned elevation or slope and finish the surface with a wooden float. Tool construction and expansion joints with an edger. Leave joint filler exposed.
2. Strike off and float the surfaces of pedestrian walkways with a wooden, cork, or magnesium float. Broom the surface lightly in a transverse direction. Use an edging tool on edges and expansion joints. Lay out surfaces in blocks with an approved grooving tool. Correct deviations of more than 1/8-inch when checked with a 5-foot straightedge.
3. For areas bonding to a future concrete pour, apply a heavy scored finish with a maximum 1/4-inch depth without dislodging the coarse aggregate or exposing the reinforcing steel.
4. Surface Under Bearings.
   a. When setting plates on concrete less than 1/8-inch thick, provide a float finish. Grind the masonry plate contact area to provide full and even bearing.
   b. When setting plates on concrete between 1/8 and 1/2-inch thick, finish the concrete surface with a steel trowel. Provide a finished surface that varies by no more than 1/16-inch. Grind surfaces that fail to conform to the required flatness.
   c. When setting plates on concrete 1/2-inch or greater in thickness and for concrete under elastomeric bearings, provide a float finish.

D. Additional Considerations.

1. Weather and environmental concerns, see Section 610.3.5
2. Placing concrete underwater or in slurry:
   a. Submit a placement plan when placing concrete underwater.
   b. Before placing tremie concrete, ensure the foundation area is level and all forms and surfaces are free of mud and silt.
   c. Equipment
      i. Use a minimum 8-inch diameter tremie tube with a smooth interior face, a watertight discharge, long enough to reach the bottom of the placement and marked in 1-foot increments.
      ii. Attach tremie tube to a funnel or hopper with a capacity of at least 1/2 cubic yard.
      iii. Provide a valve at the lower end of the discharge tube that closes tightly while charging the tremie and lowering it into position. The valve must be able to be fully open in the lowered position. Alternately, provide a foam rubber plug in the hopper that moves through the tremie tube when pushed by the concrete, forcing water or slurry from the tremie tube.
      iv. Provide at least 2 tremie tubes to ensure continuous concrete placement.
   d. Maneuver the tremie tube by using equipment that allows free vertical movement of the discharge end of the tube. Do not move the tremie laterally during concrete placement. Keep the discharge end of the tremie tube fully submerged in the freshly deposited concrete to prevent water infiltration.

e. Place tremie concrete in 1 continuous operation. Place concrete at a rate that prevents aggregate segregation, allows flow over the entire placement area, and keeps the concrete level in the tremie tube stable. 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. Do not place tremie concrete by pumping directly to the bottom of placement. Place tremie concrete only in the presence of the engineer.

f. Cure test specimens under similar conditions until meeting the requirements of Table 610.3-2.

g. Before placing fresh concrete against concrete deposited in water or slurry, remove unsatisfactory material from the concrete surface by means that do not damage the concrete surface. Chip off high spots on the concrete surface that would prevent placement of steel reinforcing bars.

3. Mass Concrete.

a. 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 2 independent sets of interior and exterior points for each element to provide redundancy in case of a device failure. 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.

b. Provide monitoring devices with automatic sensing and recording instruments that record information at a maximum interval of 15-minutes. Provide devices that operate for a maximum range of 0 to 200 degrees with an accuracy of +/- 2 degrees F.

c. The specialty engineer, or a person designated by the specialty engineer, must inspect and approve the installation of monitoring devices.

d. Do not place any mass concrete until the engineer has accepted the mass concrete plans.

4. Bridge decks.

a. Before any deck concreting, hold a pre-pour meeting with representatives of the Department and the contractor. Review the approved bridge deck placement plan and procedures for deck construction.

b. Screeds.

i. Provide a power-actuated oscillating mechanical screed of the transverse type that is rigid, easy to control, of sufficient weight to strike off the surface at the specified grade, and provides a uniform treatment over the deck surface. Unless a longitudinal construction joint has received approval under the construction joint plan, use transverse screeds that extend the full width of the deck between curbs or parapets.

(1) Set the screed and transverse construction joints parallel to the nearest abutment or pier support lines. If the skew angle changes at supports, adjust the angle of the screed accordingly as the finishing machine progresses across the deck slab. If a longitudinal construction joint is approved, place the portion on either side of the joint and finish separately.

(2) Ensure that the screed wheels bear on temporary rails supported and placed directly above the main structural members, or on form supports. Ensure that the rails are rigid enough to permit the screed to finish the surface of the deck within the requirements of this section.

(3) When placing the rails within the roadway area, elevate the rails above the deck to allow 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 allow removal to at least 2-inches below the top surface of the deck slab. Place a fusion bonded epoxy coating or other approved corrosion resistant material on all portions of the rail support to remain in the deck concrete. When placing rail supports in that portion of the deck, under the curbs, or parapets, place the supports at least 2-inches from the face of the curb, parapet walls, or outside edge of the slab.

(4) Place and secure screed supports before concrete placement. Set supports to elevations necessary to obtain a bridge deck true to the required grade and cross-section, with allowances made for anticipated settlement. Provide supports that will ensure no springing or deflection occurs under the weight of the finishing equipment, and located so that finishing equipment may operate without interruption over the entire bridge deck.

ii. Do not use vibrating screeds or longitudinal type screeds unless specifically approved by the engineer.

c. Provide bridges for working over, but not on, the concrete surface for hand-finishing, to apply fog sprays and curing compounds, and for inspection. Support the work bridge or platform outside the limits of the concrete placement.

d. Conduct a dry run of the equipment before placing concrete. Ensure that the equipment set-up maintains clear cover of reinforcement, accounts for roadway grades and cross-slopes, and incorporates deflection from the wet deck concrete to produce the final deck elevations given in the contract. Before placing bridge deck concrete, check all falsework and make all necessary adjustments.

e. Do not place concrete in bridge decks until the engineer is satisfied that the:

i. Dry run was successfully completed;

ii. personnel and equipment, as identified in the approved bridge deck placement plan, will deliver, place, spread, finish, and cure a minimum of 20 cubic yards of concrete per hour;

iii. all finishing tools and equipment are in satisfactory condition for use; and

iv. weather protective equipment is provided.

f. Place concrete in accordance with the bridge deck placement plan and procedures discussed at the pre-pour meeting. Place particular emphasis on proper concrete vibration to avoid tears, aggregate silhouettes, honeycombs, and voids, especially at construction joints, expansion joints, valleys, and ends of form sheets.

i. On continuous steel beam or girder spans, cast the deck in the order shown in the contract. On simple spans, and for all sections between construction joints for continuous spans, place the concrete by beginning at the end and working along the roadway. After the initial placement in any 1 section of a continuous span, do not make any placement until the cylinder strength of all previously placed concrete in the deck of that group reaches at least 0.5f ‘c.

ii. 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.

g. Finish bridge decks and approach slabs to a smooth surface using approved power- driven finishing machines. Use hand finish methods for irregular areas when approved.

   i. After striking off the concrete, texture bridge deck and approach slab surfaces by first dragging fabric over the final screeded concrete.

   ii. To remove local irregularities, finish the surface with a float or other approved device and to leave sufficient mortar at the surface of the concrete for subsequent texturing. Finish the surface without adding water.

h. Curing Bridge Decks.

   i. Cure the bridge deck by keeping the surface wet with clean, fresh water for a curing period of at least 14-days after placing concrete. Begin curing by fog spraying during the placing and finishing operations. Apply fogging continuously, rather than intermittently, after the finishing operation until wet covering material has been placed over the concrete surface. Augment with hand-held fogging equipment as needed.

   ii. Keep the surface continuously wet for the entire curing period by covering with two layers of wet burlap or one layer of wet burlap plus a polyethylene sheet or a polyethylene coated burlap blanket.

   iii. Apply curing protection within 15-minutes after depositing the concrete and before the surface of the concrete has lost its surface wetness or sheen appearance. Submerge the burlap in water for at least 8-hours before the scheduled start of the concrete placement. Drain the burlap of excess water prior to the application. Provide burlap that is free from cuts, tears, uneven weaving, and contaminants. Place the burlap such that the edges are lapped a minimum of 6-inches. Commence continuous burlap wetting 10-minutes after its placement and keep continuously wet and protected from displacement for the entire curing period.

   iv. Keep bridge decks covered and continuously wet for the entire curing period by the use of soaker hoses. Provide a system of soaker hoses that circulate water continuously and that are located to ensure a completely wet surface for the entire curing period.

i. Inspect finished deck roadway surfaces that will not receive a wearing surface overlay.

   i. Surface Testing.

      Test finished surfaces of concrete in accordance with the contract using an inertial profiler or 10-foot straight edge. The maximum allowable longitudinal and transverse deviation is 1/4-inch in 10-feet. Provide a 10-foot straight edge for testing smoothness.

   ii. Surface Corrections.

      Use diamond grinding to remove deviations exceeding 1/4-inch in 10-feet. Submit information on similar types of work performed with the proposed grinding equipment, including references if requested by the engineer.

j. Grooving.

   i. After curing of the bridge deck or approach slab and attaining at least 75 percent of, (f'_c) saw longitudinal grooves parallel to the centerlines. Complete a longitudinal grooving operation that results in a uniformly grooved deck surface. Saw grooves 1/8 to 3/16-inch wide; 3/16 to 1/4-inch deep; and on 3/4-inch centers. Terminate grooves 18-inches, plus or minus 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, end all grooves on the bridge deck surface within 6-inches of the drainage inlet perimeter. At expansion joints, end all grooves within 6-inches of the joint. Produce grooves that are continuous across joints less than 1/2-inch wide.

ii. Perform continuous removal of waste materials, including slurry, resulting from the grooving operations in accordance with Sections 106.8 and 104.12.

5. Sub-foundation concrete does not require reinforcement or vibration. Use Class C concrete for sub-foundation concrete.

6. The Department will not allow slip-forming bridge barrier unless called for in the special provisions included in the contract.

610.3.5 Weather and Environmental Conditions.

A. Hot and Dry Weather Requirements.

1. When placing concrete in hot weather, take appropriate measures to reduce the hazards of the 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. Ensure the temperature of the concrete at the point of discharge does not exceed 90 degrees F. Ensure the temperature of the concrete for bridge decks at the point of discharge does not exceed 85 degrees F.

2. If necessary, reduce the temperature of the concrete by cooling 1 or more ingredients. Cool aggregates by fogging or other 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 using ice, melt before discharging the batch from the mixing unit. Cool water by refrigeration or other means that will provide a uniform mixing water temperature.

3. Immediately before placing concrete, cool the forms, reinforcing steel, and other surfaces in contact with the concrete by water spray or other approved methods when the ambient temperature rises above 90 degrees F. 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.

4. Maintain finishing operations as close as practicable behind the placing operation so that curing may begin as soon as possible. Keep new concrete shaded from the sun, shielded from the wind, and wet with water, or protected by other methods to retain the moisture throughout the curing period. Use windscreens of sufficient dimensions, water fogging, or other approved means of supplying moisture to prevent shrinkage cracking due to moisture loss.

5. Protect bridge deck concrete from rapid evaporation during periods of low humidity, wind, or high temperatures by using the methods outlined below. Limit the evaporation rate of the exposed concrete surface to less than 0.15 pounds per square foot per hour as calculated by ACI 305 Hot Weather Concreting Figure 2.1.5. DelDOT Materials & Research Section will provide copies of the chart upon request. To maintain the deck surface evaporation rate below 0.15 pounds per square foot per hour, take 1 or more of the following actions:

a. Mist the surface of the concrete immediately behind the finishing machine and until application of the curing cover. 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.

b. Construct windscreens or enclosures to reduce wind velocity throughout the area of placement.

c. Reduce the temperature of the concrete at placement.

B. Rainy Weather Conditions.

1. Under conditions of threatening rain, only place concrete if providing protection. During rainy weather, cover new concrete to prevent damage. Provide sufficient material for covering at the site of the work for immediate use.

C. Cold Weather Requirements.

1. The Department defines the cold weather restriction as ambient temperature at the work site falling below 40 degrees F or the ambient temperature at the site falling below 50 degrees F, for a period of 12-hours or more.

2. Place concrete when the air temperature, measured at the location of the concreting operation in the shade, away from artificial heat, is above 35 degrees F. Maintain the concrete mixture at a temperature of 55 degrees F or above by heating aggregate, water, or both. Limit aggregate and water temperature to a maximum of 150 degrees F. Do not heat aggregate by direct gas or oil flame or on sheet metal over fire.

3. 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 concrete placement. Place concrete only when the temperatures of all surfaces that will come into contact with the concrete are at least 35 degrees F and maintained at a temperature of 35 degrees F or above during placement.

4. Continuously maintain the concrete surface temperature at or above the required temperatures indicated in Table 610.3-1 for the curing period defined in Section 610.3.6. Monitor maximum and minimum surface temperature with a measuring device that is accurate to within 2 degrees F. Place 1 temperature measuring device for every 1,500 square feet of curing concrete surface area in an accessible location.

Table 610.3-1. Surface Temperature Requirements During Curing

Minimum Section Size Dimension	Maximum Temperature of Concrete During Curing Period	Maximum Allowable Temperature Drop in Any 24-Hour Period During Curing
Under 1 ft	57°F	50°F
1-3 ft	57°F	40°F
Over 3ft up to 6 ft	50°F	29°F
Over 6 ft	50°F	29°F

5. Utilize enclosures that maintain the ambient temperature between 50 degrees F and 90 degrees F. Protect the concrete from contact with exhaust gases from heaters. Maintain proper humidity for curing. Heat the structure uniformly. Reduce heat gradually in the enclosure so that the temperature will not drop more than 20 degrees F in 8-hours.

6. 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. Ensure that sufficient thickness of blankets will maintain the concrete surface temperature at or above the required temperatures indicated in Table 610.3-1, for the curing period defined in Section 610.3.6. Secure blankets around the perimeter of the work 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 610.3-1 during the protection period, take immediate corrective actions.

610.3.6 Curing Concrete.

A. Cure concrete bridge decks in accordance with Section 610.3.4.D.4.h.

B. Cure newly placed non-concrete bridge decks using 1 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 leaves the surface and completing finishing operations. Cure concrete in accordance with the requirements of Table 610.3-1.

1. Three acceptable curing methods.

a. Maintain the concrete surface in a continuously wet condition by ponding, spraying, or covering with materials kept continuously and thoroughly wet. Use multiple layers of burlap, or other approved materials that do not discolor or otherwise damage the concrete.

b. Use liquid membrane-forming curing compound in accordance with Section 1045.7 on surfaces not exposed to view in the completed work, or on surfaces where approval is granted by the engineer. Apply the curing solution uniformly at the manufacturer's specified application rate. Do not use liquid membrane curing compounds on surfaces with a required rubbed finish, or on surfaces of construction joints unless the membrane is removed by sandblasting before placing new concrete against the joint. Apply curing compound immediately after form removal and the concrete is finished. Apply the solution by power operated atomizing spray equipment in 1 or 2 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 the mixture during application. Reapply the solution, at the specified rate, to membrane film damaged during the curing period by weather or construction activities.

c. Provide a secured cover of waterproof sheet material to prevent moisture loss from the concrete. Install the cover when the concrete is wet. Use sheets of the widest practical width. Overlap sheets a minimum of 6-inches and seal 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.

2. Leave forms in place without loosening for 7 uninterrupted calendar days or in accordance with Section 610.3.7. Immediately apply liquid membrane-forming curing compound in accordance with Section 610.3.6.B.1.b when forms are removed before 7 uninterrupted calendar days. Allow to cure for at least 7 uninterrupted calendar days after placing concrete.

3. For weather and environmental concerns, see Section 610.3.5.

C. Mass concrete.

1. Temperature Control.
   a. Do not exceed 160 degrees F during curing. Do not exceed the maximum temperature differential between any 2 adjacent sensors as follows:

Table 610.3-2. Maximum temperature differentials

Time	Temperature
First 24 hours	30º F
24 to 48 hours	40º F
2 to 7 calendar days	50º F
7 to 14 calendar days	60º F

2. Curing.
   a. Take measures to control differential and absolute temperatures using insulated forms, curing blankets, or internal cooling, in accordance with the temperature control plan.
   b. The specialty engineer or the designated employee must verify that the process for recording temperature readings is effective before the first placement of each size and type mass component.
   c. Begin taking readings after completing mass concrete placement and continue until reaching the maximum temperature differential 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 F of the ambient temperature. Transmit readings from monitoring devices to the engineer daily or upon request.
   d. Ensure that the designated employee is in contact at all times with the specialty engineer to receive instructions on making temperature control adjustments.
   e. Consult the specialty engineer immediately if either the differential temperature or the maximum allowable temperature is exceeded. Take immediate action, as directed by the specialty engineer, to retard further growth of the temperature differential.
   f. Provide determined temperature differentials, the summary sheet from the data logger that includes the maximum temperature, the maximum temperature differential, and a final report within 3 working days of completion of monitoring of each element.
   g. Use a specialty engineer to revise the previously accepted temperature control plan to ensure compliance on future placements. Obtain the engineer's approval of revisions to the approved plan before implementation.
   h. When mass concrete temperature differentials or maximum allowable temperature are exceeded, provide all analyses and test results deemed necessary by the engineer for determining the structural integrity and durability of the mass concrete element.
   i. Repair cracking or damage due to exceeding maximum temperature or the temperature differential in accordance with Section 610.3.9.

610.3.7 Formwork Removal and Placement of Superimposed Loads.

A. The minimum strength at which forms and supports for concrete structures must remain in place are listed in Table 610.3-3 and are defined by the strength requirements, unless otherwise noted in the contract.

Table 610.3-3. Minimum Strength Requirements

Structural Element	*Removal of Formwork*	*Placing Superimposed Vertical Dead Loads**	*Placement of Backfill*
	Strength (%f 'c)	*Strength (%f 'c)*	*Strength (%f 'c)*
Subfoundation Concrete	20	30	20
Cast-In-Place Concrete Piles	n/a	50	n/a
Footing	30	40	30
Abutment Wall, Rigid Frame Wall, and Box Culvert Wall	30	50	95
Piers/Columns	30	50	n/a
Drilled Shaft Above Grade	55	60	n/a
Pile Cap and Pier Cap	50	60	50
Arch [Span ≤ 65']**(B.F.)**	40	95	95
Arch [Span ≤ 65']**(S.F.)**	30	95	95
Concrete Beam (B.F.)	60	80	n/a
Concrete Beam (S.F.)	30	80	n/a
Slab [Span ≤ 10'] and Diaphragms**	30	85	95
Slab [Span > 10']**	50	85	95
Bridge Decks	Section 610.3.6	85	n/a
Retaining Wall, Headwall, and Wingwall	30	30	95
Parapet Wall, Curb, and Backwall	20	20	50

B.F. – bottom form S.F. – side form

* Examples are placement of parapets on slabs, placement of walls on footings, and placement of beams on pier caps.

** Slab includes slab type bridges, box culvert top slabs, rigid frame top slabs, approach slabs, moment slabs, and sleeper slabs.

B. Additional requirements for removal of formwork.

1. If the contractor intends to begin removing forms as soon as the concrete has reached the minimum required strength of Table 610.3-3, the contractor shall give the engineer written

notice, 48-hours before pouring the concrete, that the start of form removal will depend on the cylinder strength requirements.

2. Cure cylinders, cast for the specific use as cylinder strength testing for form removal, in the field under the same conditions as the placed structure concrete. Cure the 7-day and 28-day cylinders for the first 24 to 48-hours in an environment that provides satisfactory moisture and temperature control, in accordance with AASHTO T23. The contractor may supply sure-cure molds instead of match curing specimens.
3. Department personnel will test the cylinders to determine concrete strength when the contractor wants to remove forms or place loads on the concrete.

C. Additional requirements for superimposed loads.

1. The strength requirements listed in Table 610.3-3 pertain specifically to the construction operations indicated.
2. Load proposed bridges in accordance with Section 104.14 with the following additional restrictions:
   a. Do not stockpile materials or park construction equipment on the structure.
   b. Do not allow:
      i. Construction equipment to cross a completed structure until the concrete attains full design compressive strength (f ‘c) and the engineer authorizes crossing.
      ii. Construction equipment to cross rigid frames, box culverts, or arches until placement of the full fill height and the engineer authorizes crossing.
      iii. Sea water or brackish water to come into direct contact with concrete before the times indicated in Table 610.3-4, unless otherwise approved.

Table 610.3-4. Requirements for Concrete in Contact with Sea Water or Brackish Water

Water Salinity (ppm dissolved salts)	Days to Elapse Before 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

610.3.8 Finishing Formed Concrete Surfaces.

A. Apply a Class 1 ordinary surface finish to formed concrete surfaces upon form removal.

1. Use a Class 1 finish for metal forms, fiber forms, lined forms, or plywood forms in good condition.
2. Remove all form ties used for holding the forms in place. Remove and replace localized poorly bonded aggregate pockets or honey combed concrete with sound concrete or packed mortar that matches the color.
3. Fill the tie holes and other depressions or small voids with cement mortar mixed in the same proportions as that used in the body of the work. Clean and saturate with water all cavities

produced by form ties and all other holes, broken corners or edges, and other defects. Fill with cement mortar mixed in the same proportions as that used in the body of the work. For exposed surfaces, add white cement to the mortar to achieve a patch that, when dry, matches the surrounding concrete. 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.

4. On surfaces to be exposed or waterproofed:
   a. Remove fins and irregular projections;
   b. remove surface bulges or offsets with carborundum stones or discs; and
   c. grind with powered disc or sandblast with fine sand to achieve a Class One finish when approved.
5. When Class 1 finish does not produce an acceptable concrete surface, as determined by the engineer, apply a Class 2 finish to that surface.

B. Apply a Class 2 rubbed finish to all parapet surfaces and to other exposed surfaces when a Class One finish does not produce an acceptable surface. A Class 2 finish does not apply to soffits and the interior faces and bottoms of concrete girders.
   1. 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 finishing concrete. Continue rubbing until form marks, projections, and irregularities are removed; voids are filled; and a uniform surface is 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.

C. Provide a Class 3 tooled finish using formliner or a bushhammer, pick, or crandall. Conduct work only after 14 calendar days or when it is not possible to pick aggregate out of the surface. Provide a tooled finish surface that shows a grouping of broken aggregate particles in a matrix of mortar with each aggregate particle in slight relief.

D. Provide a Class 4 sandblasted finish by sandblasting the cured concrete surface with a hard, sharp sand to produce an even, fine-grained surface of cut away mortar, leaving the aggregate exposed.

E. Provide a Class 5 wire brushed or scrubbed finish by scrubbing 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 the aggregate used. Wash the surface with water mixed with a small amount of ammonia to remove all traces of acid.

610.3.9 Defective Work.

A. Inspection.
   1. The engineer will inspect cast-in-place concrete members immediately after form removal, between 7 and 30 calendar days after burdening the component with a full dead load, and a minimum of 7 calendar days after opening the bridge to full unrestricted traffic.

a. The engineer will inspect bridge decks once the deck is free of all debris, before cutting longitudinal grooves, and after completion of required deck planing.

b. Provide the access, equipment, and personnel needed for the engineer to safely perform this work. Core cracks in locations and to depths specified by the engineer.

2. 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 monitor and document the growth of individual cracks at an inspection interval the engineer will choose to determine if cracks are active or dormant after initial inspection.

3. The engineer will classify cracks as either nonstructural or structural. The contractor may review and comment on the engineer's crack classification, but the engineer will make the final determination. The engineer will determine if concrete coring is necessary when the engineer cannot determine an accurate measurement of crack depth by using a mechanical probe.

B. Corrective Action and Understrength Concrete.

1. Repair or remove and replace defective work as directed by the engineer. If the surface of the concrete contains bulged or uneven surfaces, or shows honeycombing that is not repairable, remove and replace the entire section.

a. Repair nonstructural crack repairs in accordance with Sections 613 and 628.

b. For structural cracks, provide to the engineer a structural evaluation, signed and sealed by a registered Delaware professional engineer, that includes recommended repair methods and a determination of structural capacity and durability. Upon the engineer’s approval, repair the cracked concrete.

2. The Department will consider concrete that fails to reach its full 28-day design strength f'_c as defective.

a. The contractor may challenge a concrete test result by obtaining cores from the represented work. Take challenge cores within 5 working days of notification by the Department. Take a minimum of 3-inch diameter by 3-inch deep core. Provide a minimum of 2 cores for testing at the central lab. Cut the cores from a location approved by the engineer. Hand deliver cores to a representative of the Department. The representative will return the core to the Department for testing. The contractor may accompany the cores to the central lab and witness all testing.

b. If the difference in strength between the 2 challenge cores is greater than 500-PSI, the Department will consider the core testing void and will prorate the payment, in accordance with Section 610.5.D, based upon the field-cast cylinders. The contractor shall apply corrective action in accordance with Table 610.3-5.

c. Valid compressive strength results of challenge cores will supersede field cylinder results. All decisions regarding structural adequacy, corrective action in accordance with Table 610.3-5, and prorated payment, will stand on the challenge core results. Remove, replace, or reinforce structurally inadequate work to the satisfaction of the engineer. Any result determined by the engineer to be structurally adequate, and to remain in place, may proceed through the process for corrective action and prorated payment in accordance with Table 610.3-5.

Table 610.3-5. Corrective Action and Prorated Payment for Concrete Strength

Category	PSI below Design Strength	Corrective Action and Prorated Payment
A	0 to 250 PSI below 28-day Design Strength	No repair required, full payment as specified in
B	251 to 500 PSI below 28-day Design Strength	Prorated payment as specified in Section 610.5.
C	501 to 1,000 PSI below 28-day Design Strength	Prorated payment as specified in Section 610.5 plus the application of a protective waterproofing that is approved by the Department's Materials & Research Section. The clear coating shall only pertain to the pour area that the core represents.
D	1,000 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.

610.3.10 Barrier Reflectors.

A. Install barrier reflectors in accordance with Section 723.3.J.

610.3.11 Deck Sealing.

A. Prepare the surface ahead of sealing in accordance with Section 613.3.B.

B. Seal surface exposed concrete barrier with a silane sealer meeting the requirements of Section 1045.3 in accordance with section 613.3.D.

610.4 Method of Measurement.

A. The Department will measure work acceptably completed as specified in Section 109.1 and as follows:

1. The Department will measure concrete using plan dimensions.
2. Concrete quantities will not include deduction of fillets, scorings, chamfers, and pipe openings less than 24-inches.
3. The Department will not measure concrete used to fill corrugations in stay-in-place deck formwork or deflection meeting Section 105.5.

610.5 Basis of Payment.

A. The Department will pay for concrete structures at the contract unit price per cubic yard. Price and payment constitute full for:

1. Working drawings;
2. quality control plan;
3. formwork
4. surface preparation;
5. lighting;

6. removal of unsatisfactory material;
7. providing and placing all materials;
8. barrier reflectors;
9. joints;
10. curing and finishing;
11. surface testing; and
12. disposal of surplus materials.

B. The Department will make no compensation or provide additional contract time for the analyses or tests used to determine the structural integrity and durability of a mass concrete element.

C. The Department will make no compensation for concrete cores taken to investigate crack depth, for challenge cores taken to determine concrete strength, or for corrective actions taken to remediate defective work.

D. The Department will make no payments for additional protections to prevent or catch leakage during deck pours.

E. The Department will pay for sealing in accordance with Section 613.

F. The Department will prorate payment for understrength concrete identified by Section 610.3.9 as calculated by the following equation:

$$Prorated\ Payment = \frac{Low\ Compressive\ Strength\ Concrete}{Specified\ Compressive\ Strength} \times Quantity\ of\ Concrete^{*} \times Bid\ Price$$

* the quantity the compressive strength results represent.

ITEM	DESCRIPTION	UNIT
610000	PCC MASONRY, CLASS A	CY
610001	PCC MASONRY, ABUTMENT FOOTING, CLASS A	CY
610002	PCC MASONRY, ABUTMENT ABOVE FOOTING, CLASS A	CY
610003	PCC MASONRY, PIER FOOTING, CLASS A	CY
610004	PCC MASONRY, PIER ABOVE FOOTING, CLASS A	CY
610005	PCC MASONRY, SUBSTRUCTURE, CLASS A	CY
610006	PCC MASONRY, APPROACH SLAB, CLASS A	CY
610007	PCC MASONRY, SUPERSTRUCTURE, CLASS A	CY
610008	PCC MASONRY, PARAPET, CLASS A	CY
610009	PCC MASONRY, CLASS B	CY
610010	PCC MASONRY, ABUTMENT FOOTING, CLASS B	CY
610011	PCC MASONRY, ABUTMENT ABOVE FOOTING, CLASS B	CY
610012	PCC MASONRY, PIER FOOTING, CLASS B	CY
610013	PCC MASONRY, PIER ABOVE FOOTING, CLASS B	CY

ITEM	DESCRIPTION	UNIT
610014	PCC MASONRY, SUBSTRUCTURE, CLASS B	CY
610015	PCC MASONRY, CLASS C	CY
610016	PCC MASONRY, CLASS D	CY
610017	PCC MASONRY, SUPERSTRUCTURE, CLASS D	CY
610018	PCC MASONRY, APPROACH SLAB, CLASS D	CY
610019	HIGH EARLY STRENGTH CONCRETE	CY
610020	CONCRETE ENCASEMENT	CY

SECTION 611 — CONCRETE REINFORCEMENT

611.1 Description.

This work consists of providing and placing concrete reinforcement.

611.2 Materials.

Concrete Reinforcement Section 1037

611.3 Construction.

A. Submit shop drawings detailing bar lists, bending diagrams, and type of bar for all furnished bar reinforcement. Check all bar lists and details shown in the contract for accuracy of the quantity, size, length, and dimensions before ordering bars.

B. Fabricate reinforcing bars in accordance with the CRSI Manual of Standard Practice. Bend the reinforcement cold to the shapes indicated in the contract. Perform bending in the shop before shipment and not in the field, unless shown otherwise in the contract. Do not hot-bend or straighten, weld, or thermal-cut reinforcing steel, unless otherwise specified in the contract.

C. Store reinforcement bars off the ground on platforms, skids, or other supports, and protect the reinforcement bars from damage and surface deterioration caused by exposure to conditions producing rust. Keep reinforcement bars free from materials that would reduce bond. Provide additional protection for specified materials as follows:

1. Epoxy-coated reinforcement.

   a. Store, handle, and place epoxy-coated reinforcement bars at the jobsite in accordance with ASTM D3963. Handle and store epoxy-coated reinforcement bars using methods that do not damage the epoxy coating. Provide 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 a 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.

   b. Where possible, do not store epoxy-coated reinforcement bars at the jobsite for more than 2-months. If onsite field storage exceeds or will 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. Where possible, do not store galvanized reinforcement bars at the jobsite for more than 30 calendar days. If field storage exceeds or will 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. 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 is provided to prevent contamination.

D. Coating Repair.

1. Inspect 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 in accordance with ASTM D3963 before bar placement. Replace epoxy-coated reinforcement bars if the 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. After placement, inspect the galvanized reinforcing bars and repair areas damaged during placement in accordance with ASTM A780 or ASTM A1094, whichever is applicable to the provided material.

E. Placing and fastening.

1. Place reinforcement bars as indicated. Hold in position to prevent displacement during concrete placement and consolidation. 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.
2. Tie bars with annealed iron wire or fasten the bars with metal clips. Tie bars at all intersections around the perimeter of each mat. For interior intersections, tie alternate intersections in each direction to provide a staggered tie layout. Tie bundled bars together at no more than 6-foot centers. Do not bundle more than 2 bars unless noted otherwise in the contract. When tying reinforcement bars together and lifting into place as a unit, ensure stability of the unit and maintain proper bar alignment during lifting and placement operations.
3. Provide additional protection for ties for specified materials as follows:
   a. For epoxy-coated or galvanized reinforcing bars, provide plastic-coated tie wire, epoxy-coated tie wire, or plastic clips.
   b. When tying stainless steel reinforcement bars together, provide plastic, plastic-coated, or stainless steel tie wire in accordance with 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 a minimum of 1/8-inch thick 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 reinforcement.
4. Support reinforcement bars in position using mortar blocks, wire bar supports, supplementary bars, or other devices. Use 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 the separation indicated.
   a. Provide mortar blocks of the same class as the concrete the blocks will set in. Ensure that block faces in contact with forms for exposed surfaces do not exceed 2-inches by 2-inches in size, and that the color and texture will match the concrete surface. If used on vertical or sloping surfaces, provide blocks with an embedded wire for securing the block to the reinforcement bars. If used in slabs, use either a tie wire or blocks with a groove in the top if the weight of the reinforcement bars is sufficient to hold the blocks in place. For epoxy-coated

reinforcement bars or galvanized reinforcement bars, use plastic-coated or epoxy-coated tie wires.

b. Provide 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, in accordance with 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 611.3.E.2.c. or stainless steel bar supports in accordance with 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. Use plastic 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.

5. Do not splice bars, except as indicated in the contract. If allowed, lap the reinforcement bars in accordance with the contract and wire together. Do not substitute alternate bars unless approved by the engineer.

6. 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 number 14 and 18 bars, except as provided in the AASHTO Load and Resistance Factor Design (LRFD) bridge specifications.

7. As indicated in the contract, use welded splices or mechanical splice systems. Stagger welded splices or mechanical splice system connections if possible.

a. For welded splices, use butt splices only. Only use welded splices if indicated in the contract 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. Assemble mechanical splice systems in accordance with the manufacturer's recommendations. Mark reinforcing bars with scribe marks or indelible ink before splice attachment to ensure equal embedment.

c. If using mechanical splice systems, construct sample and actual splices in the presence of the engineer. The engineer will select for testing 3 splices, either sample or actual, for each size of reinforcement bar used to verify physical properties. Submit verification samples to the Department 7 calendar days before planned placement. Do not encase mechanical splices in concrete until the engineer completes visual examination and required testing and provides approval. Mechanical splices must resist 125 percent of the specified yield strength of the bars being spliced.

d. Use an epoxy-coated mechanical splice system to splice epoxy-coated reinforcement bars. Paint the entire splice area with compatible epoxy paint after assembly of the system.

e. 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. Use chromate in accordance with ASTM A767, Section 4.3.

f. Use a stainless steel mechanical splice system to splice stainless steel reinforcement bars meeting the Unified Numbering System (UNS) designation listed in Section 611.3.E.3.b. for stainless steel reinforcement bars.

g. Splice sheets of welded wire fabric by overlapping each other enough to maintain a uniform strength and by securely fastening at the ends and edges. Ensure that the edge lap is at least 1 mesh in width plus 2-inches.

8. Field-cut or field-bend reinforcing bars when shown in the contract or when specifically directed by the engineer. Coat cut ends of coated bars and repair any damage caused by field bending in accordance with Section 611.3.D.

611.4 Method of Measurement.

A. The Department will measure work acceptably completed as follows:

1. The Department will compute the theoretical weight, as found in CRSI Manual of Standard Practice, of the reinforcing steel placed in accordance with approved shop drawings.

611.5 Basis of Payment.

A. Payment constitutes full compensation for:

1. Shop drawings;
2. fabricating;
3. providing;
4. storing;
5. placing;
6. splicing;
7. supporting, wiring, and fastening;
8. coating; and
9. removing surplus materials.

ITEM	DESCRIPTION	UNIT
611000	BAR REINFORCEMENT	LB
611001	BAR REINFORCEMENT, EPOXY COATED	LB
611002	BAR REINFORCEMENT, GALVANIZED	LB
611003	BAR REINFORCEMENT, STAINLESS STEEL	LB
611010	EPOXY COATED WELDED WIRE FABRIC REINFORCEMENT	LB

SECTION 612 — PRECAST CONCRETE

612.1 Description.

This work consists of providing and installing precast structures and precast, prestressed structures.

612.2 Materials.

A. PCC — Section 1022

1. Precast elements
   a. 28-day compressive strength of 5,000 PSI
2. Precast, prestressed elements
   a. 28-day compressive strength of 6,000 PSI
   b. Compressive strength at time of initial release of 4,800 PSI

B. Bar Reinforcement — Section 1037

1. Precast box culverts 12-feet x 12-feet or smaller. — ASTM C1577

C. Prestressing and Post-Tensioning Strands — Section 1038

1. Anchorages, fittings, and couplings in accordance with the contract and the manufacturer's recommendation.

D. Galvanized Angles and Plates — Section 1039

1. Anchor studs automatic end-welded

E. Silane Based Concrete Sealer — Section 1045.3

F. Closed-Cell Neoprene Sponge — Section 1042.5.B

G. Joint Wrap — ASTM C877

H. Non-Shrink Grout — Section 1047.2

I. Epoxy Grout — Section 1047.3

J. Flowable Fill — Section 1047.1

612.3 Construction.

612.3.1 Submittals.

A. Submit a complete set of detailed shop drawings for the precast concrete units or prestressed concrete beams. Include the following, as applicable:

1. An overall plan showing all units together;
2. details of each type of unit;
3. plan view of reinforcement for irregularly shaped sections;
4. placement details for embedded accessories. Show that no conflicts exist among the planned positions of embedded items or reinforcement. Show required concrete cover.
5. reinforcing bar list;

6. bill of materials including all accessories; and
7. the method and sequence of post-tensioning.

B. If the contractor proposes an alternate design, submit supporting calculations certified by a registered Delaware professional engineer.

1. For precast box culverts 12-feet x 12-feet or smaller, design in accordance with ASTM C1577.
2. For all other elements, design in accordance with the design specification noted in the contract. Use AASHTO HL93 loading or Delaware legal load, whichever governs.
3. Submit load ratings for HL-93, HS-20, and Delaware legal loads using the BRASS program in accordance with the latest version of the AASHTO Manual for Bridge Evaluation.
4. Design to the soil bearing resistance as shown in the contract.

612.3.2 General Manufacturing Requirements.

A. For precast elements, use National Precast Concrete Association (NPCA)-certified plants, inspected and approved by the Department to manufacture the units.

B. For prestressed elements, use precast PCI-certified plants inspected and approved by the Department to manufacture prestressed primary load carrying members.

C. All materials, equipment, processes of manufacture, and the finished units, as well as handling, storage, transportation, and erection, are subject to the inspection and approval process. Defective construction that may adversely affect the strength of a member or its performance in the bridge structure will result in rejection.

D. Provide an office at the precast facility for the inspector. The office will provide heat, air conditioning, lighting, electrical outlets, wireless internet access, bottled drinking water, a desk and chair for each occupant, and a lockable file cabinet for the engineer’s exclusive use.

E. Follow the manufacturer's recommended procedures for handling and placing the precast or prestressed units during the process of transporting, unloading, and installing the members. Handle precast units only by lifting devices provided especially for this purpose. Provide proper dunnage for storing precast units.

F. Repair damage to precast elements in accordance with Section 628.

612.3.3 Precast Concrete Elements.

A. This section applies to precast concrete box culverts, rigid frames, arches, wingwalls, and associated elements such as footings, headwalls, toewalls, and baffles.

B. Precast element fabrication.

1. Determine the section lengths and location of joints. Do not exceed a length that causes bending, distortion, or induced stress during lifting, moving, and placing the sections.
2. Joints.
   a. Provide neoprene gaskets at the joints between all precast units to make the joints watertight.
   b. For precast box culverts, provide tongue and groove joints all around.
   c. For precast rigid frames, provide shear keys all around.

3. Provide shear keys at all wingwall-to-wingwall and structure-to-wingwall joints. Prepare shear keys with an exposed aggregate surface.
4. Prepare for forming and pouring of the concrete in accordance with Section 610.
5. Provide reinforcement that meets or exceeds the minimum area of steel per foot noted in the contract or by ASTM C1577, as applicable.
   a. Place bar reinforcement in accordance with Section 611. Place reinforcement beginning at 2-inches from the end of each unit.
   b. Where ASTM C1577 is applicable, provide clear cover as per ASTM C1577. Otherwise, provide a minimum of 2-inches of clear cover.
6. Provide a minimum of 4 post-tensioning ducts and tendons for box culverts and rigid frames. Post-tension precast arches in accordance with the manufacturer's recommendations.
7. Provide weep holes as indicated in the contract. Adjust actual weep hole locations to maintain a 1-foot distance from any joint. Retain elevations in accordance with the contract. Provide weep holes of 4-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.
8. Provide a maximum of 4 devices or holes in each unit for handling purposes.
9. Cure precast concrete members manufactured in established plants with steam or radiant heat. Cure precast elements in accordance with approved plant quality control plans.
10. Provide a Class 1 surface finish in accordance with Section 610.3.8.
11. Apply silane sealer in accordance with Section 1045.3 to the top of each unit plus 2-feet down each side and to all headwalls, end faces, and exposed faces in accordance with Section 613.
12. Tolerances
    a. Internal dimensions in accordance with PCI MNL 135-0; 10.25.
    b. Do not vary slab and wall thickness design dimensions by more than plus or minus 5 percent.
    c. Variations in laying lengths of 2 opposite surfaces of any unit sections shall not have 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.
    d. The variation in section length shall not have more than 1/8-inch per foot of length with a maximum of 1/2-inch in any unit.
13. The maximum allowable variation in reinforcement position is plus or minus 3/8-inch except that the cover over the reinforcement on the external surface of the top slab shall be no less than 2-inches for earth covers less than 3-feet, except where ASTM C1577 is applicable.
    a. Steel reinforcement areas greater than those required will not result in rejection. The permissible variation in diameter of any reinforcement shall conform to the tolerances prescribed in the ASTM specification for that type of reinforcement.

C. Precast element installation.

1. Prepare the subgrade and obtain the engineer's approval of the subgrade before placing the coarse aggregate. Construct a foundation consisting of coarse aggregate in accordance with the contract.

2. For box culverts, place toe walls beneath the bottom slab at the inlet and outlet. Connect by dowels epoxy grouted into the bottom slab in accordance with the contract. Place a 1-inch non-shrink grout leveling pad before placing the culvert. Contain the coarse aggregate in place beneath the culvert while completing adjacent excavations for wingwalls using formwork or other acceptable means. Fill voids between the bottom slab of the culvert and the coarse aggregate with flowable fill before backfilling.
3. Assemble precast units in accordance with the manufacturer's recommendations and as approved by the engineer in the field. Place the precast sections in 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.
4. Post-tension precast elements such that the neoprene gaskets compress all around the joint with a 1/2-inch maximum gap between units. The maximum allowable post- tensioning force is 28,900-pounds. Upon completion of post-tensioning, verify the tolerance for the assembled units is plus or minus 1-inch per 50 linear feet and a maximum of plus or minus 2-inches for culverts over 100 feet long. For rigid frame and arch structures, ensure that the outer edge of the frame units matches the outer edge of the footing units.
5. Connect each wingwall-to-structure and wingwall-to-wingwall joint using bolted connections. Provide bolted connections consisting of a minimum of two, 3-foot x 2-foot x 1/4-inch plates per joint with at least eight, 3/4-inch bolts per plate. Place bolts a maximum of 3-inches from the joint or edge of plate. Do not use slotted holes in the plates. Secure anchor bolts using cast-in hardware or field drill holes. Where joints between precast units exceed 1/2-inch after installation, repair with non-shrink grout or Class A concrete.
6. Use a non-shrink, non-metallic grout having a minimum compressive strength at 28 calendar days of 5,000 PSI to fill the shear keys. Before applying the grout, clean and wet the surfaces. Do not allow standing water to remain in the area receiving grout. During grout placement, prevent material from falling on the roadway, into the waterway, or on the railroad area below. Prepare, place, and cure in accordance with the manufacturer's recommendations.
7. Cover the joint exterior with a minimum of a 9-inch-wide wrap centered on the joint. Ensure that the joint wrap stays in place during backfilling.
8. Before backfilling, use non-shrink grout to fill all post-tensioning pockets and ducts, lifting eyes, footing keyways, and all other holes or pockets. Cover grout filled locations on the fill face with joint wrap material a minimum length and width of 9-inches.
9. Place material to equal elevations on both sides of the precast structure while backfilling. Do not allow a difference in backfill height of more than 1-foot.
10. Once installed:
    a. Apply superimposed loads to precast structures in accordance with Section 610.3.7.C.
    b. Precast elements are subject to the provisions of Section 610.3.9.

612.3.4 Precast Prestressed Concrete Load-carrying Members.

A. Prestressed element fabrication.

1. Prepare for forming and pouring concrete in accordance with Section 610. Prepare shear key surfaces with an in-form retarder to create an exposed aggregate surface.

2. Provide beam dap details that show beams resting level on bearing devices and details for non-bearing areas as necessary. Provide batter to make beam ends vertical when installed.
3. Provide a 1-inch-deep recess around local strand groups with 2-inches minimum edge clearance.
4. Place bar reinforcement in accordance with Section 611. Provide a minimum of 2-inches clear cover unless noted otherwise in the contract. Adjust reinforcing bar spacing to clear embedded accessories.
5. Provide lifting devices as necessary. Do not place lifting devices in conflict with prestressed strands.
6. Provide threaded inserts at diaphragm connections. Provide threaded inserts with a minimum ultimate pullout capacity of 11,900-pounds each. Adjust threaded inserts or bar locations by 1/2-inch to avoid conflicts. Note any deviations from this plan on the working drawings.
7. Provide appurtenances in prestressed beams, in accordance with the contract, for later installation of stay-in-place forms or falsework. The stay-in-place form manufacturer shall determine the size, type, spacing, and location of the appurtenances.
8. Provide formwork to create interior voids in accordance with Section 604.3.2.C.
9. Finish the top of the beam in accordance with Section 610.3.4.C. Provide a heavy-scored finish for beams that will have a concrete deck cast-in-place on the beams. Provide a float finish for beams planned for overlays of waterproofing membranes, hot mix riding surfaces, or thin concrete.
10. Pre-tensioning.
    a. Bring strands that will receive pre-stressing in a group to a uniform initial tension of approximately 500 pounds per strand, before applying full pre-tensioning. Measure the stress using a dynamometer or other approved means. Use the initial tension as a check against elongations computed and measured. After this initial tensioning, stress the group of strands until attaining the required elongation and jacking pressure. Measure the stress induced in the strands using jacking gauges and by elongations of the strands. The calculated stress based on the elongation should closely match the gauge reading.
    b. Equip jacks with calibrated gauges for registering jacking pressures. Provide a means for measuring the pre-stressing strand elongation to at least the nearest 1/16-inch. Provide documentation to show that the jacking equipment and gauges used in manufacturing the pre-stressed members received calibration by a reputable testing laboratory. Allow for all possible slippage or relaxation of the anchorage in the interpretation and analysis of the elongations and jacking pressures.
    c. If there is a discrepancy of as much as 5 percent between the stresses determined by the jacking pressure and the elongation measurement, check the entire operation and determine the source of the error before continuing.
    d. After stressing of the strands and placing all other reinforcement and embedded accessories, place the concrete in the form. Only place concrete when the temperature is between 50 and 85 degrees F. Maintain cable or strand stresses between anchorages until the concrete reaches 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.

e. 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. Provide steam of 100 percent relative humidity. Do not discharge steam directly onto concrete or form. Ensure that the temperature within the enclosure increases at a rate not exceeding 40 degrees F per hour until reaching a maximum temperature of 140 to 160 degrees F. Maintain the maximum temperature until the concrete has reached the specified release strength. After attaining release strength, gradually decrease the temperature within the enclosure 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. Record curing temperatures throughout the process.

f. De-tension immediately following the curing period while the concrete retains its warmth and moisture. Do not allow the concrete to dry or cool before 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 minimizes sudden or shock loading and limit the maximum eccentricity about the vertical axis to 1 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.

11. After completing the pre-stress release, cut the strands flush with the ends of the member and paint with either an approved bitumastic compound or waterproofing compound. Fill strand recesses with pneumatically applied mortar. As an alternate, use an approved epoxy mortar covering the ends of strands with a minimum thickness of 1/8-inch.
12. Provide a Class One finish on beam sides and bottoms.
13. Apply a silane sealer in accordance with Section 1045.3 to the bottom and sides of the finished beams, in accordance with Section 613.
14. Do not ship until the members attain at least the minimum 28-day compressive strength, but in no case less than 3 working days after the placing concrete in the forms. Maintain the members horizontally at all times during handling, moving, storing, and shipping.
15. Permissible tolerances remain in accordance with the PCI.

B. Prestressed concrete element installation.

1. Install bearing devices in accordance with Section 623 and the contract.
2. For adjacent beams, install shear keys in accordance with the contract. Place non-shrink grout in dowel holes, as shown in the contract, in accordance with Section 612.3.3.C.6. Do not allow loads on prestressed elements until the grout has cured.
3. For bulb-T beams, install intermediate diaphragms, in accordance with the contract.

612.4 Method of Measurement.

A. The Department will measure the quantity of precast box culvert, precast rigid frame, and precast retaining wall placed and accepted using plan quantities of cubic yards of concrete. The Department will measure box culverts and associated elements such as toe walls, headwalls, and baffles as part of the box culvert. The Department will measure footings and headwalls for rigid frames as part of the rigid frame.

B. The Department will not measure the quantity of precast concrete arch, precast concrete retaining wall for arches, or prestressed reinforced concrete members.

612.5 Basis of Payment.

A. Price and payment will constitute full compensation for providing all concrete, reinforcing bar, and other materials, contractor's alternate designs, fabricating, transporting, and placing the units on site. The Department will consider anything not measured separately as incidental to the respective item.

B. The Department will pay for:

1. Excavation and backfill under Section 207 and
2. coarse aggregate under Section 302.

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

SECTION 613 — CONCRETE COATINGS AND MEMBRANES

613.1 Description.

This work consists of providing and applying coating systems and waterproofing for concrete structures.

613.2 Materials.

A.	Epoxy Concrete Sealer	Section 1045
B.	Silicone-Based Acrylic Concrete Sealer	Section 1045
C.	Silane Based Concrete Sealer	Section 1045.3
D.	High-Molecular Weight Methacrylate Concrete Sealer	Section 1045
E.	Waterproofing Membranes	Section 1045
F.	Aesthetic Staining	Section 1045
G.	Mortar Sand	Section 1003

613.3 Construction.

A. Submittals.

1. Submit a manufacturer's letter of certification for an approved installer or arrange to have a manufacturer's representative on site during surface preparation and coating application.
2. Supply a MSDS and a certificate of compliance of the batch and lot for each shipment of concrete sealer materials. Provide a manufacturer's analysis report of the materials used with the specified batch shipped to the job site.
3. Provide the manufacturer's instructions for installing the system at least 2-weeks before beginning surface preparation.

B. Surface preparation and coating application.

1. Cure concrete in accordance with Section 610 or the time specified in the manufacturer's recommendations, whichever is longer. Complete texturing, saw cutting, grooving, and repointing on new concrete surfaces before preparing the surface for sealer. Complete repairs on existing concrete surfaces in accordance with Section 628.
2. Remove loose material, grease, dirt, salt, efflorescence, laitance, curing compound, previous sealers and paints, and other matter from concrete surfaces in accordance with ASTM D4258 and SSPC-SP-13. Do not use sandblasting or shot-blasting on textured or form-lined concrete surfaces or on surfaces to receive aesthetic staining.
3. For new concrete, high-pressure-wash the surface with water at a flow rate and pressure sufficient to clean, but not damage the concrete surface. Repair concrete surface damage resulting from the high-pressure wash. After high-pressure washing or a rain event, allow 48-hours for the surface to dry before continuing the surface preparation process.
4. For existing concrete, shot-blast the surface with a pressure sufficient to clean the surface and remove dirt, debris, laitance, oil, and any other unallowable material without damaging the concrete. Vacuum and remove all shot and removed material.

5. Blow the surface area clean with oil-free compressed air immediately before coating application.
6. Protect private and public property, pedestrians, workers, and vehicles on, beneath, or adjacent to the structure from the effects of surface preparation and sealer applications.
7. Apply coatings and membranes when the range of surface and ambient temperatures and weather conditions recommended by the manufacturer are forecast to continue until the coating cures.
8. Do not begin applying coating until the engineer approves the surface preparation work.

C. Epoxy concrete 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. Do not allow drips, runs, or sags 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-based acrylic sealer, and silane-based concrete 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. Apply a minimum of 2 coats. Follow the manufacturer's recommendations for drying times between coats. Calculate the yield for each concrete surface and submit to the engineer. If the yield does not meet the minimum coverage rate, recoat the entire area.
3. Follow the manufacturer's recommendation for coating thickness. Do not allow drips, runs, or sags during application. Use a brush, roller, or sprayer to perform the application.
4. Allow silicone-based acrylic sealer to dry 1-week before testing adhesion, in accordance with ASTM D7234.
5. Do not allow traffic on the treated surface until the waterproofing solution is completely absorbed and the surface is dry and, in accordance with the manufacturer's recommendations.

E. High molecular weight methacrylate concrete sealer.

1. Follow the manufacturer's safety precautions for using all materials and equipment. Store materials in accordance with the manufacturer's recommendations. Fire codes may require special storage facilities for some components of the system.
2. Apply the crack sealing material without thinning or alteration in accordance with the manufacturer’s recommendations.
3. If excess material remains on the surface after completing crack sealing, cover the area with a light broadcast of a dry sand meeting the requirements of Section 1003. Use only enough sand needed to absorb the excess material. Follow the manufacturer's recommendation regarding sand broadcast timing. Brush off excess sand when the sealer has dried.

4. Keep traffic off the treated surface for a minimum of 4-hours when temperatures are 70 degrees F and above and for a minimum of 6-hours when temperatures are below 70 degrees F.
5. Open treated surface to traffic only after receiving approval from the engineer.

F. Waterproofing membranes.

1. Remove hot mix and roadway fill to expose the existing concrete deck. Patch holes or voids in the concrete deck in accordance with Section 628. Remove sharp protrusions.
2. For locations where bituminous overlay is placed directly on top of the membrane, provide a membrane capable of withstanding the asphalt temperature at placement.
3. Place the membrane and other system components in accordance with the manufacturer's recommendations.
4. Overlap the membrane sheets by at least 3-inches or as specified by the manufacturer, whichever is greater. Stagger membrane overlaps in the transverse direction.
5. 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.
6. Place a tack coat on the membrane before the overlay application.

G. Aesthetic Staining.

1. Provide a penetrating stain mix and compatible coloring agents designed for exterior application on new or old concrete with field evidence of resistance to moisture, alkali, acid, mildew, mold, and fungus discoloration or degradation. Use a coloring agent that breathes, allowing transmission of moisture and vapor.
2. Provide stains and coloring agents to produce the appearance, texture, color combinations and patterns, and range of colors in accordance with the contract. Colors may include a base color, heavy accent color, light accent color, speckling color, and a joint color.
3. Provide a finished surface free of blemishes, discolorations, surface voids, and conspicuous form marks. Repair all surface problems created by the surface preparation method with patching material that matches the texture and color of the surrounding concrete.
4. Apply stain in accordance with the manufacturer's recommendations. Unless otherwise noted, apply 2 coats of stain. Apply stain to sample panels or test sections first to establish acceptable colors and patterns. Once approved by the engineer, apply stain to structures in the field after structure completion, at the locations shown in the contract.

613.4 Method of Measurement.

A. The Department will measure the quantity of concrete coatings as the number of square feet of concrete surface area coated and accepted.

B. For aesthetic staining, the Department will measure an approved sample panel as an additional concrete surface area.

C. The Department will not measure the quantity of sealer for precast concrete elements.

613.5 Basis of Payment.

A. Price and payment for concrete coatings will constitute full compensation for:

1. The technical representative;
2. providing all materials;
3. providing, placing, and removing scaffolding;
4. surface preparation;
5. application of coating material;
6. disposal of discarded materials; and
7. recoating due to low application rates.

B. The Department will not pay for aesthetic staining of rejected sample panels or test sections.

C. The Department will pay for:

1. Removal of roadway fill and hot mix above existing concrete decks in accordance with Section 202;
2. sealers applied to precast concrete elements in accordance with Section 612; and
3. concrete patching and repair in accordance with Section 628.

ITEM	DESCRIPTION	UNIT
613000	EPOXY CONCRETE SEALER	SF
613001	SILICONE-BASED ACRYLIC CONCRETE SEALER	SF
613002	SILANE-BASED CONCRETE SEALER	SF
613003	HIGH MOLECULAR WEIGHT METHACRYLATE CONCRETE SEALER	SF
613004	WATERPROOFING MEMBRANE, TRAFFIC BEARING	SF
613005	WATERPROOFING MEMBRANE, NON-TRAFFIC BEARING	SF
613006	AESTHETIC STAINING	SF

SECTION 614 – ULTRA HIGH-PERFORMANCE CONCRETE

614.1 Description

This work consists of providing, mixing, transporting, placing, finishing, curing, and grinding Ultra High-Performance Concrete (UHPC).

614.2 Materials

A. Fine Aggregate

1. Use crushed quartz with 100% passing the No. 30 sieve and a maximum of 3% passing the No. 200 sieve.

B. PCC	Section 1020
C. Steel Fibers	ASTM A820, Type 1
1. Closure Pours	2 percent by volume
D. Water and Ice	Section 1021
E. Admixtures	As required by manufacturer.
F. Liquid Membrane Compounds	Section 1045.7
G. Polyethylene Sheeting	Section 1022.6.B

614.3 Construction

614.3.1 Submittals

A. Submit trial batch of UHPC per 1025.3.A.

B. Submit a Quality Control Plan to verify that all materials, equipment, and workmanship meet the contract requirements. Provide detailed personnel, equipment, methods, sequence, and procedures to ensure the specified quality of all applicable materials and related field operations. Follow the submittal procedures outlined in Section 105.4. Provide the following information in the plan, as applicable:

1. Batch proportions, production sequence, and production rates.
2. Allowable ambient temperature and weather conditions for mixing and placement.
3. Construction loads with locations applied to the bridge during UHPC placement.
4. Surface preparation procedures, including cleaning and pre-wetting.
5. When performing closure pours, provide:

a. Formwork information, including materials and removal.

b. Locations of construction joints.

c. Placement procedures.

d. Procedures for supplemental heating of surrounding prefabricated elements.

6. Method of curing, including means and materials.

C. Temperature Control Plan. When temperature ranges fall outside of the manufacturer's recommended placement temperatures, submit a Temperature Control Plan in accordance with Section 610.3.1 and the manufacturer's recommendations.

D. Prior to the start of UHPC placement, schedule an on-site meeting with the UHPC manufacturer's representative, the Contractor, and the Engineer to review the approved Quality Control Plan and clearly outline the procedures for mixing, transporting, finishing, and curing of the UHPC.

614.3.2 Surface Preparation

A. Prior to placing UHPC, pre-wet surfaces to a saturated surface dry (SSD) condition, in accordance with the UHPC manufacturer's recommendations. An SSD condition is defined as a concrete surface that has absorbed the maximum amount of water without ponding on the surface.

B. For UHPC closure pours, create an exposed aggregate, 1/4-inch amplitude finish on all concrete surfaces that will be in contact with UHPC.

1. Achieve SSD by placing wet burlap on the surface for a minimum of 24-hours or by other means submitted for approval by the engineer.
2. Use compressed air, free of oil, to blow out any standing water.

614.3.3 Formwork

A. Design and fabricate formwork in accordance with Section 604.03.2 and the recommendations of the UHPC manufacturer.

1. Construct forms from a nonabsorbent homogeneous material that is properly sealed and capable of resisting the hydrostatic pressures from UHPC in the unhardened state.
2. Cover all UHPC closure pours with a top form with a moisture barrier.
3. Do not remove formwork until a compressive strength of 10-ksi is achieved.

614.3.4 Mixing

A. Mix UHPC batches in accordance with the manufacturer's requirements.

B. Provide a minimum of two portable batching units for mixing of the UHPC. Mixing equipment which is not supplied by the UHPC manufacturer must be reviewed by the UHPC manufacturer for adequacy.

C. A representative from the UHPC manufacturer must be present during mixing, transporting, placing, finishing, and curing of the UHPC.

614.3.5 Placing **and Curing**

A. Place and cure the UHPC in accordance with the manufacturer's recommendations, the Quality Control Plan, and the Temperature Control Plan.

B. Use in-place temperature monitors to monitor curing temperatures.

C. When placing UHPC closure pours:

1. Do not internally vibrate the UHPC. Rodding may be used to achieve a suitable blended connection where two successive pours meet.

2. Supplemental heat may be provided to the UHPC and surrounding prefabricated elements to reduce initial set times and accelerate strength gain.

614.3.6 Su**rface Profile and Finish**

A. Finish surfaces of UHPC closure pours to be flush with adjacent precast elements to within a tolerance of plus 1/4-inch and minus 0-inches by grinding.

1. Grind the UHPC surface after the UHPC has achieved a minimum compressive strength of 10-ksi.
2. During grinding operations, if steel fiber pullout is observed, suspend the grinding, and do not resume until approved by the engineer.
3. Perform a watertight integrity test on 10-percent of the joints after grinding has been completed.
   a. Continuously apply running water at a rate of 300-gallons per hour along the length of the joints to be tested, for a duration of 30-minutes.
   b. The Engineer will inspect the underside of the joint for water leakage at 30-minutes and at 1-hour.
   c. The joint is considered watertight if no dripping water or water droplets are visible underneath precast concrete element areas along the full length of the joint. If the results of the watertight integrity test are not satisfactory, the engineer will determine the required corrective action.
4. Traffic is not permitted on the bridge until the UHPC has achieved a minimum compressive strength of 14-ksi.

614.4 Method of Measurement

A. The Department will measure the quantity of UHPC Closure Pour as the number of cubic feet of UHPC placed and accepted.

614.5 Basis of Payment

A. The Department will pay for UHPC Closure Pour at the contract unit price per cubic foot. Price and payment constitute full compensation for:

1. Quality Control Plan;
2. formwork;
3. providing and placing all materials;
4. mixing and transporting; and
5. finishing, curing, and grinding.

ITEM	DESCRIPTION	UNIT
614000	UHPC CLOSURE POUR	CF

SECTION 615 — STEEL STRUCTURES

615.1 Description.

This work consists of providing, fabricating, and erecting steel structures and structural steel elements of other structures.

615.2 Materials.

A.	Coatings	Section 616
B.	Bearing Materials	Section 623
C.	Structural Steel	Section 1039.1
D.	Fasteners	Section 1039.2 and 1039.3
E.	Anchor Bolts	Section 1039.4
F.	Welded Shear Connectors	Section 1039.5
G.	Forgings, Shaftings, and Castings	Section 1039.6 and 1039.7
H.	Sheet Zinc and Copper	Section 1039.9
I.	Galvanizing	Section 1039.10

615.3 Construction.

A. Submittals:

1. Certifications.
   a. For structural steel, provide documentation that the fabricator has the AISC Certified Steel Bridge Fabricator – Advanced Certification (ABR).
      i. For fracture-critical bridges, provide additional documentation that the fabricator has the AISC Fracture Critical Endorsement.
   b. For welding, all welders shall possess a current AWS welder's qualification card, which shall be available upon request at all times.
2. Shop Drawings.
   a. Prepare and submit shop drawings at least 30 calendar days before fabrication for each detail of the plans requiring the use of structural steel, forgings, wrought iron, or castings in accordance with AASHTO/NSBA Steel Bridges Collaboration G1.3 Shop Detail Drawing Presentation. In addition to the AASHTO/NSBA requirements, include the following:
      i. Joint details for all welds.
      ii. Bill of material on each sheet.
      iii. Charpy V-Notch (CVN) requirements for each piece.
      iv. Fracture-critical requirements for each piece including indicating fracture-critical areas of members.
      v. Title block in the lower right corner of each sheet with the following information:

(1) Project identification data including federal and state project numbers.

(2) Sheet numbering for shop drawings.

(3) Bridge number as identified in the plans.

(4) Name of owner.

(5) Name of fabricator or supplier.

(6) Name of contractor.

vi. Camber diagrams showing the camber at each panel point for trusses or arch ribs, at field splices, and fractions of span length (quarter points minimum) for continuous beams and girders or rigid frames.

b. A PE stamp is not required for Shop Drawings.

3. Erection drawings.

a. Prepare and submit erection drawings and calculations at least 30 calendar days before erecting any portion of the structural steel.

b. Prepare erection drawings in accordance with AASHTO/NSBA Steel Bridge Collaboration S10.1 Steel Bridge Erection Guide Specification. Include drawings of all falsework bents, bracing, guys, dead-men, lifting devices, and attachments to bridge members. Show the sequence of erection, location of cranes and barges, crane capacities, location of lifting points on the members, and weights of the members.

c. Prepare calculations showing that temporary stresses and deflections will not cause permanent damage to the steel members. Prepare calculations showing that the stability of partial and complete girders is maintained throughout all phases and stages of erection until all girders and diaphragms are in place and all bolts are properly installed. Evaluate steel members for erection loads including self-weight, wind loading in accordance with the LRFD Guide Specification for Wind Load on Bridges in Construction, and construction live loading.

d. Drawings and calculations shall be stamped by a Professional Engineer registered in the State of Delaware.

4. Alternate designs.

a. If the contractor proposes an alternate design, submit supporting calculations and shop drawings certified by a registered Delaware professional engineer.

b. Conform to Section 105.12 for hauling.

c. If girders cannot be shipped in the lengths shown on the plans, the contractor may submit for approval a shop drawing of additional field splice(s) with prior approval of the Bridge Design Engineer. Include the locations of additional field splices and all revised splice details in shop and erection drawings.

5. Welding procedure specifications (WPS).

a. Submit WPSs and test reports in accordance with the applicable ANSI/AWS code before fabrication begins. Notify the engineer which procedures with be used for each joint or joint type. Do not begin fabrication until the engineer approved WPSs.

B. Fabrication:

1. Perform all fabrication of bridge members in accordance with AASHTO/NSBA Steel Bridge Collaboration S2.1Steel Bridge Fabrication Guide. Where AASHTO/NSBA refer to AASHTO LRFD Bridge Design Specifications or AASHTO LRFD Bridge Construction Specifications, use the version identified in the plans.
2. Requirements of Section 615 are in addition to AASHTO/NSBA S2.1. Follow the requirement in Section 615 if there is a conflict between Section 615 and AASHTO/NSBA S2.1.
3. Follow all applicable provisions of the appropriate version of ANSI/AWS D1.5. Refer to ANSI/AWS D1.3 Structural Welding Code – Sheet Steel when welding sheet steel thinner than 1/8-inch.
4. Give at least 7 days notice before commencing fabrication work. Include a schedule for all major fabrication processes and dates when inspections are to occur. Perform no work in the plant before the engineer authorizes fabrication. Pay the Department's travel costs when changes to the contractor's fabrication or inspection schedules are not adequately conveyed to the Department.
5. Material identification.
   a. Assembly-mark individual pieces and issue cutting instructions to the shop using a system that will maintain identity of the original piece.
   b. Identify structural steel by standard and grade of steel. Also differentiate between material toughness requirements (CVN, fracture-critical) as well as any other special physical requirements. In addition, identify structural steel for primary members by mill identification numbers (heat numbers). Use an approved identification system. Use either paint or low-stress stencils to make identification markings on the metal. Mark the material as soon as it enters the shop and carry the markings on all pieces through final fabrication. Transfer the markings before cutting steel for primary members of bridge structures into smaller pieces. Loss of identification marking on any piece, with no other positive identification, or loss of heat number identification on any primary member piece will render the piece unacceptable for use.
6. Welding.
   a. Trim plates with rolled edges used for webs by thermal cutting.
   b. Use weld tabs at least 2-inches long for manual and semi-automatic processes, at least 3-inches long for automatic processes, and in all cases at least as long as the thickness of the material being welded. Use longer weld tabs as required for satisfactory work.
   c. Terminate fillet welds approximately 1/4-inch from the end of the attachment except for galvanized structures and flange-to-web welds, for which the fillet weld must run the full length of the attachment, unless otherwise shown on the plans.
   d. Keep surfaces within 4-inches of groove welds or within 2-inches of fillet welds free from shop paint.
   e. For galvanized assemblies, completely seal all edges of tightly contacting surfaces by welding before galvanizing.
   f. Do not use hand-held semiautomatic submerged-arc welding (SAW) for welding bridge members unless altered to provide automatic guidance or otherwise approved.

g. Keep at least 6-inches between shop splices and stiffeners or cross-frames. Obtain approval for shop splices added after shop drawings are approved.

h. For splice welds, grind shop groove welds in flange plates smooth and flush with the base metal on all surfaces whether the joined parts are of equal or unequal thickness. Grind so the finished grinding marks run in the direction of stress, and keep the metal below the blue brittle range (below 350 degrees F). Groove welds in web plates, except at locations of intersecting welds, need not be ground unless shown on the plans except as required to meet the appropriate version of the ANSI/AWS welding code requirements.

i. Never restrain a joint on both sides when welding.

j. Stiffener Installation.

  i. Members must meet combined tilt and warpage tolerances before the installation of stiffeners.

  ii. Cut stiffeners to fit acceptable flange tilt and cupping. The engineer will permit minor jacking or hammering that does not permanently deform the material.

  iii. Tack weld intermediate stiffeners within 12-inches of a welded field splice point in the shop. Weld the stiffeners in the field in accordance with the appropriate version of the ANSI/AWS welding code after the splice is made.

k. Perform magnetic particle testing (MT), radiographic testing (RT), or ultrasonic testing (UT) as specified in D1.5 for bridge structures. The engineer will periodically witness, examine, verify, and interpret NDT. Additional welds may be designated for NDT on the plans. Retest repaired groove welds per the applicable ANSI/AWS code after repairs are made and have cooled to ambient temperature. Complete NDT and repairs before assembly of parts into a member, but after any heat-correction of weld distortion.

  i. Radiographs must have a density of at least 2.5 and no more than 3.5, as a radiographer confirms. The density in any single radiograph showing a continuous area of constant thickness must not vary in this area by more than 0.5. Use only ASTM System Class I radiographic film as described in ASTM E1815. Use low-stress stencils to make radiograph location identification marks on the steel.

  ii. Have UT equipment calibrated yearly by an authorized representative of the equipment manufacturer or by an approved testing laboratory.

  iii. Use half-wave rectified DC when using the yoke method unless otherwise approved. Welds may be further evaluated with the prod method for detecting centerline cracking.

l. If problems develop during galvanizing of welded material, the engineer may require a test of the compatibility of the combined galvanizing and welding procedures in accordance with this section and may require modification of 1 or both of the galvanizing and welding procedures.

  i. Prepare a test specimen with a minimum length of 12-inches using the same base material, with the same joint configuration, and using the welding procedure proposed for production work if testing is required. Clean and galvanize this test specimen using the same conditions and procedure that will be applied to the production galvanizing.

  ii. Examine the test specimen after galvanizing. There must be no evidence of excessive buildup of zinc coating over the weld area. Excessive zinc coating buildup will require modification of the galvanizing procedure.

iii. Remove the zinc from the weld area of the test specimen and visually examine the surface. There must be no evidence of loss of weld metal or any deterioration of the base metal due to the galvanizing or welding procedure. Modify the galvanizing or welding procedure as required if there is evidence of deterioration or loss of weld metal, and run a satisfactory retest on the modified procedures before production work. Report procedures and results on the galvanized weldment worksheet provided by the Department.

7. Prepped and painted in accordance with Section 616.
8. Store structural steel, plain or fabricated, above the ground on platforms, skids, or other supports. Keep steel free from dirt, grease, and other matter, and protect it from corrosion. Store high-strength fasteners as specified in Section 615.3.C.8.a.
9. Plates.
   a. Cut and fabricate steel plates for main members and splice plates for flanges and main tension members so the primary direction of rolling remains parallel to the main tensile and compressive stresses.
   b. 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. Perform oxygen cutting in accordance with AASHTO/AWS D1.5 bridge welding code.
      ii. Perform visual inspection and repair of plate-cut edges in accordance with AASHTO/AWS D1.5 bridge welding code.
   c. For bent plates, adhere to the requirements of Section 11.4.3.3 of AASHTO LRFD Bridge Construction Specifications.
10. Mill or grind bearing ends of bearing and jacking stiffeners to provide the fit specified in the applicable version of ANSI/AWS D1.5.
11. Ensure intermediate stiffeners fit tightly against the compression flange. Ensure the surface finish for bearing, base plates, and other bearing surfaces that contact each other or concrete are in accordance with Table 615.3-1.

Table 615.3-1. ANSI Surface Roughness Values

Bearing Surface	in. × 10^{-6}
Steel slabs	2,000
Heavy plates in contact in welded shoes	1,000
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

12. Member tolerances.
    a. 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; and

iii. refer to AASHTO/AWS D1.5, bridge welding code, for tolerances for camber and sweep of continuous and simply supported girders of any shape. The camber and sweep tolerances for steel pier caps are the same as those specified for girders. Measure sweep for horizontally curved members from the theoretical centerline for comparison to the aforementioned requirements. In anticipation of uneven shrinkage, adjust camber ordinates accordingly.

b. If measuring girder length with a device that is free of thermal effects, adjust the measurements accordingly. All dimensions given are based on an ambient temperature of 68 degrees F. Measure the length of horizontally curved girders along the arc.

13. Straighten plates, angles, other shapes, and built-up members without fracturing or damaging the metal. Perform heat-straightening of AASHTO M270 Grades 70W, 100, and 100W steel members only under rigidly controlled conditions, subject to approval of the engineer. Do not exceed the temperature values specified in Table 615.3-2.

Table 615.3-2. Maximum Straightening Temperature

Material to Be Straightened	Maximum Temperature (°F)
Grade 70W > 6 inches from weld	1,050
Grade 70W < 6 inches from weld	900
Grade 100 and 100W > 6 inches from weld	1,100
Grade 100 and 100W < 6 inches from weld	950

a. The maximum straightening temperature for all other steels is 1,200 degrees F. 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.

b. Ensure parts to be heat-straightened are free of stress and external forces, including stresses from mechanical means used to apply the heat.

c. The engineer will reject all straightened pieces showing evidence of fracture.

d. Make sharp corners into round edges by grinding for exposed edges of painted steel.

14. Heat curving.

a. Heat-curving of beams and girders can occur 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.

b. 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.

c. 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.

d. Conduct heat-curving operations at temperatures less than 1,150 degrees F. Do not artificially cool the girder until it has naturally cooled to 600 degrees F. Obtain approval for the method of artificial cooling.

e. 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.

15. When curved in the horizontal position, support the girder near its ends and at intermediate points to obtain a uniform curvature. 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.

16. Bolt Holes for high-strength bolts and unfinished bolts:

a. Punch or drill bolt holes as follows:

i. Either sub-drill and ream, sub-punch and ream, or drill full-size holes. The standard hole size is the bolt diameter plus 1/16-inch.

ii. Full-size holes may be drilled or punched in unassembled pieces using computer numerically controlled (CNC) drilling or punching equipment. Holes punched full-size shall meet Article 11.4.8.1 of the specified edition of AASHTO LRFD Bridge Construction Specifications.

(1) Holes drilled or punched full-size using CNC equipment may be drilled or punched either through individual unassembled pieces or drilled fill-size through any combination of pieces held together.

(2) Demonstrate the accuracy of the drilling or punching procedures by means of a check assembly of the primary load-carrying components of the structure.

iii. When specified, sub-punch or sub-drill all holes 1/4-inch smaller than the final hole diameter. Sub-drill if thickness limitation governs. After assembling, ream or drill to full size.

iv. When specified, the contractor may use enlarged or slotted holes for high-strength bolts.

b. 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. For drilled holes, either sub-drill and ream or drill full-size 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 roto-broach cutters. Assemble and securely hold connecting members while reaming or drilling holes. Match-mark before disassembling.

d. Use steel templates that have hardened steel bushings in the holes and have accurate dimensions 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.

e. Hole Tolerances:

i. Individual hole.

(1) 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. For slotted holes, 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.

ii. Hole group.

(1) Before reaming, punch full-sized, sub-punched, or sub-drilled holes so that, after assembling and before any reaming occurs, it is possible to insert a cylindrical pin into the member, 1/8-inch smaller in diameter than the nominal size of the punched hole, 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.

(2) Ensure that, when reaming or drilling holes, 85 percent of the holes in any contiguous group show no offset greater than 1/32-inch between adjacent pieces.

iii. 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.

17. Clean and coat fabricated work in accordance with Section 616.

C. Assembly:

1. For bolted connections, prepare contact surfaces in accordance with Section 616 before assembling. Remove all burrs and shavings, and ensure the member is free from twists, bends, and other deformations.

a. When assembling, allow enough drifting to bring the parts into position. Do not allow the drifting to enlarge the holes or distort the metal.

b. Install bolts with bolt heads on the bottom of bottom flanges and the exterior face of exterior girders.

2. Prepare edges according to AASHTO/AWS D1.5 Bridge Welding Code.

3. As required in Section 615.3.B.16, verify the accuracy of CNC drilling or punching procedures by means of a check assembly of the primary load carrying components of the structure including stringers, plate girders, tub girders, trusses, and cross-frames or diaphragms of curved and skewed bridges. Verify the camber, alignment, and accuracy of holes in the check assembly. If the check assembly fails in any of these areas, further check assemblies may be required by the Department. Use a minimum of 3 contiguous field sections for the check assembly.

a. For trusses, use 3 contiguous truss panels.

b. For projects with only 2 contiguous field sections, use both sections.

c. Progressive check assemblies are permitted provided that 3 contiguous sections are in assembly at all times and 1 section is removed from the assembly as a new section is added.

4. Prepare holes for bolted connections as specified in Section 615.3.C.16. Where applicable, assemble major components with milled ends of compression members in full bearing and then ream the sub-sized holes to the specified size while assembling the connections.

5. Before performing field-welded connections, prepare or verify the fit of members including the proper space between abutting flanges with the segment preassembled.

6. When specified, provide 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.

a. Provide unfinished bolts unless otherwise specified.

b. When specified, 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.

7. For connections using high-strength bolts, use ASTM F3125 high-strength bolts, or equivalent fasteners, installed to develop the minimum required bolt tension specified in Table 615.3-5. Install bolts in holes formed as specified in Section 615.3.C.16. When using turn-of-nut tightening method, provide hardened washers under the element turned in tightening.

a. For 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 tightening the bolts. 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. 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 material. Remove burrs and any other material that would prevent solid seating of the connected parts in the snug condition.

c. Paint the faying surface as designated in the AASHTO LRFD Bridge Design Specifications.

d. Meet the following requirements, as applicable, for the faying surfaces:

i. Blast-clean and coat in accordance with Section 616.

ii. Assemble after the coating has cured for the minimum time used in the qualifying test.

8. Bolts and fasteners:

a. Hot-dip galvanize faying surfaces of fastener assemblies in accordance with AASHTO M111. Assemble and assign lot numbers before shipping. Protect faying surfaces from dirt and moisture. Remove from protective storage only the number of assemblies planned for installation and tensioning during a work shift. Return unused assemblies to protected storage at the end of the shift. Do not clean assemblies or remove manufacturer-applied lubricant as-delivered unless instructed by the manufacturer. Clean assemblies for slip-critical connections that accumulate rust or dirt resulting from job site conditions. Clean, re-lubricate, and test for rotational capacity before 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.

b. Provide a bolt-tension measuring device, meeting ASTM F 959, to perform the rotational capacity test and to confirm the ability to satisfy the requirements of Table 615.3-3. If approved, the contractor may use alternative design direct tension indicators (DTI) devices, provided the devices meet the above requirements or approved manufacturer specifications.

c. For short-grip bolts, the contractor may use DTIs 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.

d. Inspect and tension bolt, nut, and washer assemblies to the minimum tension specified in Table 615.3-3. Use impact wrenches to tension each bolt in approximately 10-seconds.

Table 615.3-3. Minimum Required ASTM F3125 Bolt Tension (U.S. Customary Units)

Bolt Diameter (inch)	Grade 325 (pound)	Grade 490 (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	64,000	80,000
1 1/4	81,000	102,000
1 3/8	97,000	121,000
1 1/2	118,000	148,000

e. Do not reuse Grade 490 fasteners or galvanized Grade 325 fasteners. The contractor may reuse ungalvanized Grade 325 bolts, if approved.

Table **615.3-4. 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

f. Install bolts in all holes of the connection and bring the connection to a snug condition.

g. Snug systematically from the most rigid part of the connection to the free edges. Repeat until the full connection is in a snug condition.

h. The minimum required bolt tension is 70 percent of the specified minimum tensile strength of bolts rounded to the nearest 1,000-pounds. Refer to ASTM specifications for tests of full-size A325 and A490 bolts, loaded in axial tension.

i. 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.

j. Perform tests for all fastener assemblies. Include washers as part of the test even if not required as part of the installation procedure. If members are galvanized, test for rotational capacity after galvanizing process.

k. Perform the rotational capacity test in accordance with ASTM A325 and 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 2 assemblies per rotational capacity lot.

l. For bolts long enough to fit in a Skidmore-Wilhelm Calibrator, assemble the bolt, nut, and washer assembly in this device or an acceptable equivalent.

m. Ensure the torque necessary to produce the required fastener tension does not exceed the value obtained by the following equation:

$$\text{Torque} \le 0.25PD$$

where:

Torque = measured torque (foot-pounds)
P = measured bolt tension (pounds)
D = bolt diameter (foot)

n. Test bolts 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 615.3-3.

o. Use a hardened beveled washer to compensate for the lack of parallelism 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.

   i. Ensure that square or rectangular hardened beveled washers for American Standard Beams and Channels meet ASTM F436 and taper in thickness.

   ii. Hardened washers are not required for connections using ASTM F3125, Grade 325 bolts except as follows:

p. Use hardened washers under the element turned when tightening using the calibrated wrench method.

   i. Hardened steel washers are required as part of rotational-capacity tests, even if the washers are not required in the actual installation.

   ii. When installing ASTM F3125, Grade 490 bolts in material having a specified minimum yield strength less than 50 kips per square inch, irrespective of the tightening method.

   iii. When installing ASTM F3125, Grade 490 bolts, over 1-inch in diameter, in an oversize or short slotted hole in an outer-ply. In these cases, use a 5/16-inch minimum thickness washer under both the head and the nut. Do not use multiple hardened washers stacked upon one another.

   iv. When installing ASTM F3125, Grade 325 bolts 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. Provide 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.

q. For the turn of the nut installation method, hardened washers are not required except as specified in Section 615.3.C.8.I.

   i. Check a representative sample of no fewer than 3 bolt and nut assemblies of each diameter, length, and grade used in the work. Use a device capable off 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 no less than 5 percent greater than the tension required by Table 615.3-3. Retest as required.

   ii. Following the snug-tightening operation, tension bolts in the connection by the amount of rotation specified in Table 615.3-4. 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.

r. Use the calibrated wrench installation method only when calibration of wrenches takes place on a daily basis, and when using a hardened washer under the turned element. Use standard torques, determined from tables or from formulas.

s. When using calibrated wrenches for installation, set the wrenches to deliver a torque calibrated to produce a tension of no less than 5 percent in excess of the minimum tension, specified in Table 615.3-3. Calibrate the installation procedures by verification testing at least

once each working day for each fastener assembly lot installed that day. Verify by testing 3 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 a significant difference occurs 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 615.3-4. For manual torque wrenches, measure while nuts become torqued in the tensioning direction.

t. 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 become tensioned as required.

u. When tightening of bolts using DTI devices, assemble a representative sample of not less than 3 devices, for each diameter and grade of fastener 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 pre-tensioned connections. Use the calibration test to demonstrate that the device indicates a tension no less than 5 percent greater than that specified in Table 615.3-3.

When installing bolts using DTI conforming to the requirements of ASTM F959, install bolts in all holes of the connection and bring to snug tight conditions. Indication of snug tight appears by partial compression of the direct tension indicator protrusions. Provide a maximum gap of 0.005-inch after installation. Tighten all fasteners, progressing systematically from the most rigid part of the connection to the free edges, in a manner that minimizes relaxation of previously tightened fasteners.

v. In the presence of the engineer, inspect tightened bolts using a calibrated torque wrench, unless using alternate fasteners or DTI that allow verification by other methods. Conduct the inspection before a loss of lubrication or corrosion influences the tightening torque.

w. Place 3 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 used on the structure. If not using washers, 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 or approximately 1-inch at a 12-inch radius, in the tensioning direction. The inspection torque required for the work is the average of the torque required for all 3 bolts.

x. Randomly select 10 percent, or at least 2 bolts, 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 properly tensioned. If the torque turns 1 or more bolt heads or nuts, apply the job inspection torque to all bolts in the connection. Re-torque and re-inspect any bolt where a head or nut turns.

9. Ensure that welding, welder qualifications, and prequalification of weld details and inspection of welds are in accordance with AASHTO/AWS D1.5 Bridge Welding Code.

   Do not weld or tack brackets, clips, shipping devices, or other material to any member not required, unless specified.

D. Erection:

1. Construct falsework and forms in accordance with Section 604.
2. Store material on skids. Keep storage area clean and properly drained. Store girders and beams upright. Support long members to prevent damage from deflection.
3. Provide bearings and anchorages in accordance with Section 623. Verify dimensions and elevations before ordering superstructure materials for staged construction projects.
4. Follow the 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.
5. Provide temporary bracing or stiffening devices to accommodate handling stresses in individual members or segments of the structure during erection.
6. 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.
7. Assemble using match marks. Ensure parts have no damage or distortion. Clean bearing surfaces, and surfaces planned for permanent contact, before assembly. Fill a minimum 1/2 of the holes in splices and field connections, using equal numbers of bolts and cylindrical erection pins, before installing and tightening the balance of high-strength bolts. Fill 3/4 of the holes in splices and connections carrying traffic during erection.
8. Use fitting-up bolts that have the same high-strength bolts used in the installation. If required to use other fitting-up bolts, use the same nominal diameter as the high-strength bolts. Use cylindrical erection pins 1/32-inch larger than the bolts.
9. Provide 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.
10. Correct minor misfits by a minor amount of reaming, cutting, grinding, and chipping. Errors in shop fabrication, or deformation resulting from handling and transporting, will result in rejection.
    a. Steel structures repair:
       i. Replace rivets or bolts with high strength bolts at locations identified in the contract.
       ii. When replacing a group of rivets or bolts, remove 1 rivet at a time and immediately replace with a high-strength bolt before removal of the next rivet or bolt.
11. Ensure that welding removal and repair, welder qualifications, and prequalification of weld details and inspection of welds in accordance with AASHTO/AWS D1.5 Bridge Welding Code.

12. For 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.

    a. Incorporate high heat input into the localized areas of the steel, with a minimum amount of heat spread into the surrounding material. Use an approximately 1-inch diameter, #3, multi-orifice Rosebud heating torch operating on approximately 25 PSI MAPP and 125 PSI oxygen. Do not use smaller or larger torches. Obtain approval of the equipment from the engineer before using a torch.

    b. Confine heating to the patterns described here. Conduct heating such that the desired steel location becomes heated to between 1,000 and 1,100 degrees F, as rapidly as possible, without overheating. Any heating procedures that heat any location on the girder to a temperature greater than 1,200 degrees F results in destructive heating. Repair or replace steel damaged by overheating.

    c. Confine heating patterns to the areas required to bring the member back to its original position. The engineer will approve the heat pattern location areas in the field before the beginning of the process.

    d. During heating operations, to measure the heat intensity, provide and use temperature indicating crayons manufactured for 600, 1,000, 1,100, 1,200, and 1,250 degrees F temperature limits.

    e. Do not quench with water, or water and air. Perform cooling with dry compressed air after the steel has cooled to 600 degrees F.

    f. After removing the beam deformation, to the engineer's satisfaction, clean and paint the entire surface area indicated in the contract in accordance with Section 616. Match the paint color of the steel beam under repair to the color of the existing paint.

615.4 Method of Measurement.

A. The Department will measure work acceptably completed in accordance with Section 109.1 and as follows:

B. The Department will compute pay quantities for each type of steel and iron from working drawings using Table 615.4-1:

Table 615.4-1. 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

C. The Department 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.

D. The Department 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.

E. The Department 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 from then weight measurements. 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.

F. The measurement will make no allowances for the weight of paint or galvanizing.

G. The Department will measure all metal parts other than metal reinforcement for concrete unless otherwise stipulated.

H. The Department will compute pay weight on the basis of computed net weight using 1 of the following:

1. The Department 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 Department's 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.

I. The Department's measurement will include the weight of fillet welds as specified in Table 615.4-2:

Table 615.4-2. Department's Measurement of the Weight of Fillet Weld by Size in Inches.

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	0.80
3/4	1.10
7/8	1.49
1	2.00

615.5 Basis of Payment.

A. Price and payment for shop painting of new steel is incidental to the applicable steel structures item and will constitute full compensation for:

1. Providing shop drawings;

2. all submittals;
3. contractor's alternate designs;
4. fabrication;
5. storing;
6. transporting;
7. assembly;
8. hardware;
9. repairs;
10. repainting and surface preparation;
11. providing all materials;
12. providing protection against damage during paint application;
13. re-establishing project standards, if necessary;
14. re-cleaning when the contractor does not apply primer within 8 hours of initial cleaning; and
15. re-cleaning and repainting surfaces after use of unauthorized solvents, after application of paint containing thinners after applying paint to contaminated surfaces, and after applying paint contrary to the requirements of this section.

B. Such payment is full compensation for providing all materials, equipment, labor, and all incidentals required to complete the work as specified.

C. The Department will not pay for additional check assemblies when failing any of the check assembly verifications.

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	EACH
615005	STEEL STRUCTURE REPAIR	LB
615006	STEEL STRUCTURE REPAIR	LS
615007	WELDING REPAIR	LF

SECTION 616 — STEEL COATINGS

616.1 Description.

This work consists of providing and applying coating systems for structural steel.

616.2 Materials.

A. Provide 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. Use a stripe coat of a different color. Ensure that all coats are from one paint system from one manufacturer.
4. Use a finish coat color that matches chip number 25183 (cyan-blue) of AMS-STD-595A for all structural steel unless otherwise specified in the contract.
5. Use a finish coat color that matches chip number 25183 (cyan-blue) of AMS-STD-595A for weathered steel, unless otherwise specified in the contract.
6. When painting just beam ends of weathering steel, use a finish coat color that matches chip number 30059 (Brown) of AMS-STD-595A, unless otherwise specified in the contract documents.
7. Match the color and gloss of the touch up finish coat on existing steel to the existing finish coat.

B. Provide expendable abrasives that meet SSPC-AB 1 and recyclable abrasives that meet SSPC-AB 3.

616.3 Construction.

616.3.1 Submittals.

A. Contractor's / Subcontractor's SSPC-QP Certification.

1. Submit certifications for contractors and subcontractors removing or applying paint in accordance with SSPC-QP1 - Standard Procedure for Evaluating Qualifications of Painting Contractors: Field Application to Complex Structures.
2. Submit certifications for contractors and subcontractors when the paint is being removed by abrasive blast cleaning in accordance with SSPC-QP2, Category A - Standard Procedure for Evaluating Qualifications of Painting Contractors to Remove Hazardous Paint.
3. Provide certificates that are effective prior to award of contract and remain in effect for the duration of the contract.

B. Personnel Qualifications.

1. Provide a QC inspector on site full time during cleaning and painting operations. Provide documentation that personnel performing quality control related functions are experienced and qualified to perform the work and have completed the training specified for SSPC-QP1, and when abrasive blasting or work on paint containing toxic metals is being disturbed, SSPC-QP2.
2. Provide a Competent Person, as specified in SSPC-QP2, on site full time when abrasive blasting or paint containing toxic metals is being disturbed. This person will perform all quality control related functions involving the oversight of worker and environmental protection, containment performance, and waste handling. Provide documentation of qualifications, including experience and records of training as specified in SSPC-QP2. This person must hold a current SSPC C3 Competent Person Certificate or current C5 refresher certificate and a certificate of completion of 29 CFR 1926.62(l) Lead in Construction Training.
3. Provide the services of a third party Certified Industrial Hygienist (CIH) or Certified Safety Professional (CSP) when the work involves abrasive blasting or the disturbance or removal of paint containing toxic metals.
   a. Provide documentation that the CIH or CSP has the following qualifications and insurance requirements:
      i. Certification by the American Board of Industrial Hygiene or Board of Certified Safety Professionals;
      ii. Field sampling and oversight experience involving removal of paint that contains toxic metals from structures;
      iii. $1,000,000 errors and omissions insurance coverage for this type of work.
   b. The CIH/CSP, or by an employee working under the direct supervision of the CIH/CSP, will:
      i. Monitor worker exposures during paint disturbance operations at each structure and provide worker protection oversight.
      ii. Perform all field sampling and testing in the presence of a representative of the Department. Notify the Department at least 24 hours prior to sampling and testing.
      iii. review all results of sampling and testing performed on the project.
      iv. prepare written reports interpreting these results for compliance to the applicable regulations.
      v. Submit a copy of all reports, analyses, and test results to the engineer within 5 working days after sampling.
      vi. Prepare, sign, and submit a written certification within 5 days after the end of each month stating that the contractor has complied with the Plans of Action and Compliance Programs contained within this specification for worker protection, environmental protection, and waste handling; and has addressed all deficiencies found.

C. Abrasives.

1. Provide material safety data sheets (MSDS) for the abrasives and a letter from the abrasive supplier indicating that expendable abrasives meet SSPC-AB 1, and recyclable abrasives meet SSPC-AB 3. Verify the cleanliness of recycled abrasives according to SSPC-AB.

D. Paint Manufacturer Certifications and Letters.

1. Submit the coating manufacturer's written certification for approval to DelDOT Materials & Research to confirm that the coatings being used meets the NEPCOAT Qualified Products List for primer, intermediate, and finish coats before the start of painting. The engineer will confirm that the product used in the field meets the product approved by DelDOT Materials & Research.
2. When detergents or additives are proposed to be incorporated into the water used for washing, provide MSDS and a letter from the coating manufacturer that approves the use of the detergents with their coating.
3. Provide a letter that approves proposed solvents for use in solvent cleaning prior to painting or between coats. Provide MSDS for the solvents.
4. Submit, for approval, the coating manufacturer's technical data sheets for each coat (primer, intermediate, and finish) to DelDOT Materials and Research detailing 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
5. 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 paint in containers having expired shelf life dates from the site.
6. When caulking is used, provide a letter from the coating manufacturer identifying the recommended caulking material, the application sequence for integrating the caulking into the coating system between Coats II and III, and the minimum cure time prior to paint application.
7. Prior to use, provide a copy of the certified test results to the engineer specifying that the paint conforms to the specification.

E. Quality Control (QC) Plans.

1. Submit a Quality Control Plan for providing daily job quality control per SSPC-QP1 for surface preparation and painting operations. Include the following:
   a. Records of standards and specifications for coating inspection work and their utilization.
   b. System for filing inspection reports.
   c. Demonstration that inspection equipment and calibration standards and procedures for calibrating the inspection equipment are available.
   d. Procedures to stop nonconforming work.
   e. Procedures for verifying proper coating application.
   f. Procedures to ensure that each major operation is inspected and the inspection results documented. Include the following in contractor QC inspections:
      i. Effectiveness of the containment system to control project debris, paint spatters, overspray, drips, paint spills, and all work materials, while painting over roadways, waterways, machinery areas, and areas in the vicinity of abutments and private properties;
      ii. Ambient conditions;
      iii. Compressed air cleanliness and, if required, acceptability for breathing;
      iv. Surface preparation (solvent cleaning, pressure washing, hand/power tool cleaning, abrasive blast cleaning or other cleaning methods specified in the plans);
      v. Coating application (specified materials, mixing, thinning, and wet film thickness);
      vi. Dry film thickness per coat;
      vii. Recoat times and cleanliness between coats;
      viii. Coating continuity and coverage (free from runs, sags, overspray, dry spray, pinholes, shadow-through, skips, holidays, variations in gloss, thin or heavy thickness)
2. Maintain on site copies of the contractor's daily job quality control records throughout the project and make them available when requested by the engineer. If records are not made available within 3 working days, stop work until the contractor provides the required QC reports. Submit records from on-site audits and inspections from SSPC, OSHA and EPA as requested by the engineer.

F. Containment System Plans.

1. At least 30 days prior to commencing cleaning operations, submit containment system working drawings, sealed by a professional engineer registered in the State of Delaware in accordance with Section 105.4, to the Department including the following:
   a. a containment system capable of capturing, containing, and collecting the waste and resulting residue generated by the work, including abrasive blasting residue, spent blasting mediums, rust, paint chips and debris, paint droplets and spills, overspray, and dust. Strive to achieve total containment (100 percent). 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 2A unless specified otherwise.

b. Use a containment system, safety devices, or equipment that does not encroach upon the minimum bridge clearances indicated in the contract, unless otherwise approved by the engineer.

c. Details of the containment system in plan and elevation views including:

i. all containment system components such as rigid framework, work platforms, and scaffolding.

ii. details of clips and hangers. Permanent attachments or fasteners to the bridge will not be permitted.

iii. methods for weighing down all curtains, screens and tarps used for containment. Methods for maintaining the containment system seal during all operations.

iv. methods for preventing leakage of waste and residue by covering the decking material with fire retardant plastic, impermeable screens, or tarpaulins when using steel corrugated decking containment system materials.

v. when using suspended containment screens, use a maximum mesh opening of 17 mils.

d. When cleaning structures over water, include a skimming boom, consisting of a float with a skirt or other approved system, for emergency backup collection of 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. Show the locations of skimming booms and capturing devices.

e. In accordance with Section 104.14.B, indicate the following:

i. points of attachment to the structure and ensure that those locations are capable of supporting the proposed loads.

ii. locations and magnitudes of all loads from the proposed containment system on the existing structure, including dead, live, blast waste, and wind loads.

iii. maximum permissible load of abrasive or waste permitted on the containment system.

iv. for vehicles with abrasives and waste allowed on the bridge, indicate allowable load and locations. Vehicle and equipment loads may not be permitted behind abutments if surcharging results.

2. The Department will evaluate the effect of the containment system on the bridge to ensure that the system does not 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.

G. Worker Protection Compliance Program.

1. The contractor's employees, before being engaged in paint removal work, must have proper training in accordance with the OSHA Construction Industry Standard.

2. Regardless of the presence of toxic metals, provide a hand wash station with soap and towels at each work site. As dictated by the monitoring results and the applicable OSHA standards, provide a cleanup area with a shower, soap, hot and cold potable pressurized water; a change area with a locker; and an approved container for collecting and disposing of waste at each work site. Make the hand wash, shower facilities, and change area available to contractor and Department personnel. Provide hygiene facilities meeting 29 CFR 1926.51, Sanitation Standard.

3. When abrasive blast cleaning is conducted in the field or paint containing toxic metals is being disturbed, submit for approval a Worker Protection Compliance Program. Include the following items:
   a. meet the OSHA - Lead in Construction Standards, and other applicable toxic metal standards
   b. a plan to fulfill the requirements of Section 616.3.7.
   c. provide the services of a CIH/CSP in accordance with Section 616.3.1.B.3.
   d. a plan to submit documentation as outlined in Section 616.3.1.B.3.
   e. review, sign, and seal by the CIH/CSP. Submit on the painting contractor's letterhead.

H. Environmental Protection Plan of Action.

1. Submit an Environmental Protection Plan of Action (EPPA) fulfilling the requirements of Section 616.3.7 and confirming that the environment is protected from contamination when:
   a. the coatings are being abrasive blast cleaned, regardless of the presence of toxic metals, or
   b. the coatings being disturbed contain toxic metals, regardless of the method of preparation.
2. Include the following items in the EPPA:
   a. procedures for visible emissions assessments, monitoring and inspection of air, soil, and water on the project site, surrounding property and structures, and pavement including a location plan showing the type and placement of high-volume ambient air monitors
   b. procedures for monitoring the following specific construction activities:
      i. For paint disturbance using dry methods of preparation, address the daily visual emissions observations that will be performed and the corrective action that will be implemented in the event emissions or releases occur.
      ii. When abrasive blast cleaning, regardless of the presence of toxic metals, address the provisions for high volume ambient air monitoring (TSP-Monitoring); monitor citing, calibration, and operation; filter handling and shipping; and laboratory analysis, including the name and qualifications of the laboratory.
      iii. For paint disturbance, address the visual assessments for soil/water/sediment that will be undertaken each day and upon project completion, together with the proposed cleanup activities.
   c. provide the services of a CIH/CSP in accordance with Section 616.3.1.B.3.
   d. a plan to submit documentation as outlined in Section 616.3.1.B.3.
   e. review, sign, and seal by the CIH/CSP. Submit on the painting contractor's letterhead.

I. Waste Handling Plan of Action.

1. Submit a program for the handling, storage, transportation, and disposal, of all waste, hazardous or non-hazardous, regardless of the presence of toxic metals in accordance with Section 616.3.8 and all Federal and State regulations relating to collection, storage, and disposal of the hazardous waste and solid waste. Also include disposal of unused paint and solvent.
2. Include the following in the Plan of Action:

a. Names, addresses, and licenses for the proposed hazardous waste transporters and disposal facilities.

b. Obtain an EPA ID permit number for each structure and a permit for hauling the hazardous waste from the State Department of Natural Resources and Environmental Control (DNREC). A list of certified haulers and other information regarding handling and disposal of blast waste can be obtained from DNREC.

c. Hazardous waste handling and storage procedures.

d. Non-hazardous waste handling and storage procedures.

e. Waste and wastewater sampling and testing procedures. If the local publicly owned treatment works (POTW) authorizes the disposal of the water down the sanitary sewer system, provide a letter from the POTW authorizing the disposal.

f. provide the services of a CIH/CSP in accordance with Section 616.3.1.B.3.

g. a plan to submit documentation as outlined in Section 616.3.1.B.3.

h. review, sign, and seal by the CIH/CSP. Submit on the painting contractor's letterhead.

J. Coating System Warranty.

1. Provide a warranty guaranteeing the performance of the complete coating systems, including surface preparation, materials, and application, against failure for a period of 2-years from the date of final acceptance. Have the project warranty and guarantee signed and attested to by 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.

K. Approval of the proposed plans does not remove the responsibility to conduct the work in accordance with Federal, State, or local regulations, this specification, or to protect the health and safety of all workers involved in the project and members of the public who may be affected by the project. The contractor remains responsible for the adequacy and completeness of the programs and work practices, and adherence to them.

616.3.2 General Requirements.

A. Perform the work according to AMPP/SSPC/NACE Standards and the manufacturer's recommendations.

B. Ensure that all operations meet the requirements of OSHA, including exposure to lead, arsenic, cadmium, and chromium. Comply with 29 CFR 1926 construction safety standards and the applicable Federal, State, and local laws.

C. Prior to bidding, become familiar with the current environmental regulations and safety procedures. In accordance with the EPA's RCRA regulation, Delaware Department of Natural Resources and Environmental Control (DNREC), the Department will be considered the "Waste Generator" of the paint wastes generated by the work on existing structures.

D. The contractor will be considered the "Hazardous Waste Generator" of all other waste associated with the work. These include wastes produced such as petroleum waste, solvent related waste, unapplied waste paints, used rags, used protective clothing, and other personal protective clothing (PPE) determined to be wastes. Obtain an EPA Hazardous Waste Generator ID Number and dispose of waste under manifest as required by RCRA (40 CFR 260 thru 265, and 271).

E. Definitions of Areas to be Cleaned and Painted. The following terms designate the specific areas to be cleaned and painted:

1. All Steel Surfaces. Steel superstructure elements including but not limited to steel beams, girders, rockers, bearing assemblies, trusses, floor beams, stringers, joists, purlins, cross-bracings, lateral-bracings, diaphragms, sway-bracings, scupper downspouts, and support brackets for utilities, light poles, or sidewalks. It does not include substructure elements, railings, sign structures, utilities, or light poles unless included in the contract.
2. Bearings and Beam Ends. Bearing assemblies and all structural steel for the specified distance from the ends of the beams at the abutments, and the specified distance in each direction from the center line of the piers for a total of twice the specified distance.

F. Notify the engineer of defects in structural steel, including cracks, missing bolts or rivets, and deterioration, detected during cleaning and painting.

G. Protect utility pipes, conductors, light fixtures, and conduits from these operations. Do not clean and paint them unless specified.

616.3.3 Equipment.

A. Provide the following inspection equipment for the exclusive use of the engineer and each QA inspector, the following equipment for the QA observations of the cleaning and painting operations. Maintain, calibrate, and verify the equipment in a condition that is satisfactory to the engineer. The equipment will remain the property of the contractor at the conclusion of the contract.

1. The latest editions of SSPC-Vis 1, SSPC-Vis 3, or SSPC-Vis 4, as applicable to the project, or other approved visual standards;
2. SSPC Manual Volumes 1 and 2 (latest editions);
3. Spring micrometer with coarse and extra coarse surface profile replica tape;
4. Electric psychrometer and 1 sling psychrometer;
5. U.S. Weather Bureau Psychrometric Tables;
6. 3 surface thermometers, 0 degrees F to 150 degrees F;
7. Probe thermometer for paint temperature;
8. High/low recordable thermometer for each paint storage area;
9. Wet film thickness gauge;
10. Digital magnetic dry film coating thickness gauge capable of transferring data to a computer (SSPC-PA 2, Type 2);
11. Plastic calibration shims for digital magnetic dry film thickness gauge;
12. Inspector's mirror;

13. Wind meter;
14. Clean, white, lint-free, absorbent rags;
15. Light meter for measuring light intensity during surface preparation, painting, and inspection work;
16. Putty knife at least 40 mils thick and 1 to 3 inches wide;
17. Blotter paper;
18. Dry Film Thickness calibration plates traceable to the National Institute of Standards and Technology;
19. Measuring stick/pole to measure platform under clearance. Provide a stick/pole that is collapsible and has a minimum measuring height of 20 feet.

B. Lighting.

1. Provide lighting, including power sources, to supply adequate illumination to all surfaces being prepared, painted, or inspected, including the underside and inside of the containment system, when containment is employed.
2. Provide lighting meeting SSPC-Technology Guide No. 12 and maintain in good working condition. Adjust the floodlighting to avoid glare to marine and vehicular traffic.

616.3.4 Project Site Preparation.

A. Establish and maintain staging areas in accordance with Section 104.12.B.

B. Site Preparation prior to Surface Preparation.

1. Remove vegetation overhanging or fouling the structure.
2. When the structure has timber or plywood planking between the beams, carefully remove it in the areas of work operations. Store and maintain the planking in good condition. Dispose of all debris on the planking. Unless otherwise directed, the planking will not have to be reinstalled until cleaning and painting operations are complete. The engineer may direct that portions of the planking be reinstalled prior to opening any lane to traffic during the same working day. The engineer may also direct that planking be reinstalled during periods of work stoppage.

C. Containment System Installation and Operation.

1. Operate and maintain the containment system while work is in progress in accordance the approved working drawings. Do not deviate from the approved working drawings without prior approval of the engineer.
2. While on the site, weigh down all curtains, screens, or tarps used for containment and keep sealed at all times during water-blasting, paint removal, and painting.
3. Deny public access to all rigging, scaffolding, and the containment systems at all times.
4. Place ground tarps under all equipment and the containment where feasible to prevent accidental releases of material into the environment.
5. Prevent the leaking of grit, dust, toxic metals and debris during blast cleaning activities by covering all steel corrugated decking containment materials with either fire retardant plastic, impermeable screen or tarpaulins.

6. When working over water, collect floating debris immediately using the skimming boom. Clean the skimming boom at least once a day. Upon completion of the project, clean the skimming materials or if cleaning is not possible or practical, dispose of as hazardous or nonhazardous waste as applicable.
7. If visible emissions in excess of Section 616.3.7 occur, stop operations immediately and resume only once corrective actions are made.
8. When there are spills or releases of material designated to be collected and contained, immediately shut down the operation producing the discharge and clean up the debris. Take corrective actions to prevent similar releases in the future.

616.3.5 Surface Preparation.

A. Paint Quality Assurance (QA) Inspector Notification.

1. Notify the Department at least 5 working days prior to beginning field cleaning and painting of new and existing steel. A paint inspector will be provided to assist the engineer in performing the QA observations of the cleaning and painting portion of the work. Failure to comply with this notification will be cause for not accepting the work performed and for further work to be suspended.

B. Prepare surfaces as specified in the pertinent AMPP/SSPC/NACE Specifications and the contract. Verify surface conditions meet the pertinent SSPC-VIS Standards.

C. Methods of Cleaning.

1. NEPCOAT List A – New Steel
   a. Clean surfaces specified to be coated to white metal in accordance with SSPC-SP 5.
   b. When painting weathering steel beams, blast-clean the surfaces as outlined in the contract.
   c. Blast-clean the faying surfaces of splices and connections of all structural elements according to SSPC-SP 10.
2. NEPCOAT List B – Existing Steel
   a. Clean surfaces specified to be coated to bare metal in accordance with SSPC-SP 10 near white metal.
   b. When painting weathering steel beams, blast-clean the surfaces as outlined in the contract.
   c. Blast-clean the faying surfaces of splices and connections of all structural elements according to SSPC-SP 10.
   d. Use abrasive media to produce blasted surfaces having a surface profile height of 1.5 to 4.0-mils as determined according to ASTM D4417, Method C.
   e. Whenever the existing condition causes surface profile to exceed 4-mils on areas of existing structural steel members, 2 coats of primer must be applied to achieve the minimum dry film thickness specified above the profile.
   f. Power Tool Cleaning to Bare Metal. Perform per SSPC-SP 11 and as depicted in SSPC-Vis 3, with a surface profile of at least 1-mil.

D. Repair of Surface Imperfections.

1. Regardless of the method of cleaning, remove surface imperfections such as sharp fins and slivers, rust scale, weld spatter, and pack rust by an approved method without scarring good steel.

E. Feathering and Removal of Defects in Existing Coating.

1. For projects involving the touch up or overcoating of newly installed steel or existing coatings in the field, regardless of the method used for cleaning, feather the edges of old paint permitted to remain. Remove portions of paint on previously painted surfaces that are chalky, powdered, cracked, or otherwise unacceptable. Remove runs and sags in the existing paint on the outside facing surfaces of fascia beams over highways.

F. Surface Condition Prior to Painting.

1. Remove residual dust, dirt, and grease from the surface as the final procedure prior to painting and between coats whenever the coating is contaminated. Cleaning includes the removal of all dust, puddles, grease, oil, exhaust from trucks, debris, concrete spatter, and other foreign matter on the surfaces being painted. Also remove debris on surfaces adjacent to those being painted. Concrete spatter stains that discolor the primer need not be removed provided material is not dislodged when wiping the surface with a cloth. Cleaning involves vacuuming, solvent cleaning, hand/power tool cleaning, and pressure washing as appropriate.

2. Pressure Washing.

   a. Low Pressure Water Cleaning (LPWC). Use potable water on all bearings, transverse and longitudinal joints, and beam ends prior to abrasive blast cleaning to remove salts, bird droppings, dirt, and debris. At beam ends, wash to the limits defined in Section 616.3.2.E.2. Use LPWC as necessary between coats to remove surface contamination.

   b. Perform LPWC per SSPC-SP 12, except use a nozzle pressure of 2000 to 2500 psi together with a rotating tip 12 to 18-inches from the surface. Equip the pressure washer with easily accessible gauges and a pressure regulator. Perform LPWC no more than 96-hours prior to blast cleaning. Use this method to remove concrete spatter, dirt, debris, salt contaminants, grease, oil, and similar surface interference material from newly coated structures prior to the application of additional coats. Should the surface not be blast cleaned within 96-hours after LPWC, the engineer will determine if additional preparation is required.

   c. When the water is to be recycled and the coating being cleaned contains toxic metals, test wastewater in accordance with Section 616.3.8 before reuse. Do not reuse water that exceeds the threshold value for any toxic metal or chlorides.

3. During cleaning operations, move all containment system attachments and connections to existing steel to allow the underlying surfaces to be cleaned according to the contract. All containment attachments that cannot be moved during cleaning and painting must be power tool cleaned to SSPC-SP 11 Bare Metal.

G. Prior to the application of paint, have the QC personnel inspect the surfaces and establish that they have been prepared according to the specifications. Upon QC acceptance, obtain approval from the engineer that the surfaces to be painted during that day have been cleaned as specified.

616.3.6 Painting Operations.

A. Painting Sequence.

1. Do not paint the outside facing surfaces of beams until all concrete has been placed and parapet form brackets removed. However, the primer coat may be applied to these areas prior to placing the form brackets, provided that it is properly touched up prior to placing the next coat of paint.
2. Protect concrete from being stained by painting operations. Restore painted or stained concrete surfaces to originally intended color without damaging the concrete.
3. Proceed with cleaning and painting by sections, bays, or other readily identifiable parts of the work as approved.
4. Start the work at the top and proceed toward the bottom.

B. Paint Storage and Mixing.

1. Store paints and thinners in well ventilated areas that are not subject to excessive heat, open flames, electrical discharge, and direct rays of the sun. Store paint in tightly covered containers at an ambient temperature of at least 45 degrees F. Store materials in heated areas when necessary. Adhere to the manufacturer's recommendations. Do not use materials that have exceeded manufacturer's temperature allowances.
2. Use materials on a rotating stock basis, and leave containers closed until used. Maintain containers in a clean condition, free of foreign materials and residue.
3. Do not use paints that cannot be stirred to normal consistency. Remove and discard thin skins formed in the container. Do not use material that is livered, gelled, thick skinned, or otherwise questionable.
4. Mix paints per manufacturer's instructions and as approved. Do not thin the paint unless authorized by the paint manufacturer and approved the engineer. Thin paint in the presence of the engineer. For multiple component paints, mix and use only complete kits. Partial kit mixing is prohibited. Do not use materials that are beyond their pot life or shelf life.
5. Remove waste chemical solutions, oily rags, and other waste daily. Take precautionary measures to ensure protection of workers and work areas from fire hazards and health hazards resulting from handling, mixing, and applying materials.

C. Paint Representative.

1. Provide a technical representative from the paint manufacturer. During initial execution of the work, the engineer may require the paint representative to be on-site to approve, with the engineer, the degree of cleanliness prior to painting, and the method of application of the coating system. The engineer may stop paint operations for failure to meet this requirement regardless of the reason for the failure. In areas cleaned prior to ceasing paint operations, reclean if required by the engineer.

D. Weather Requirements for Painting.

1. Painting is allowed when:
   a. There is no rain, snow, fog, or mist dampening the surface.
   b. The relative humidity does not exceed the maximum humidity specified by the paint manufacturer.
   c. The ambient air temperature in the shade is above 40 degrees F.

d. The surface temperature is above 35 degrees F or the minimum temperature specified by the paint manufacturer, whichever is greater, and must be maintained until the paint achieves time to recoat.

e. The surface temperature is 5 degrees F minimum above the dew point until cure or intermediate coats have been top coated.

f. The surface temperature is below 120 degrees F or temperature value recommended by the paint manufacturer, whichever is less.

2. Schedule the operations so that all cleaned surfaces are painted within 8-hours. If rust bloom appears or the air or steel temperature falls below 5 degrees F above the dew point after cleaning and prior to application of the primer coat, reclean the affected areas in accordance with Section 616.3.5.

3. When environmental conditions fall outside of acceptable parameters during painting operations and fresh paint is damaged as a result, perform corrective action to repair or replace the damaged paint.

4. Paint operations may be stopped by the engineer due to wind. Stop painting operations if the wind velocity exceeds 20 mph, unless specific and approved precautions are taken to prevent the escape of paint droplets and overspray.

E. Artificial Climate Controls.

1. Maintain minimum temperature (substrate, air, and material) and all other environmental restrictions in accordance with Section 616.3.6.D.

2. If heat is to be used to reach environmental conditions, use only an indirect heat source that will disperse the heat evenly throughout the containment area.

3. Maintain heat in accordance with the manufacturer's recommendations or time to recoat, whichever is greater, after the coating is completed in the desired areas.

4. Install and operate an automatic temperature data recorder inside the containment area until time to recoat or manufacturer's recommendations, whichever is greater. The engineer will determine placement.

5. Failure to maintain artificial climate controls will be cause suspension of work until weather dictates that artificial climate controls are not needed.

F. Application of Prime, Intermediate, and Finish Coats.

1. For field painting, meet SSPC-PA 1 for paint application.

2. Apply all paint according to the manufacturer's product data sheets. Spray painting will be permitted provided the engineer approves the location and method of spray application. On moveable bridges, paint all areas adjacent to machinery, mechanical components, and electrical components by brush application unless the engineer approves spray application. On surfaces inaccessible (Limited Access) for painting by regular means, apply paint using sheepskin daubers or by other means as necessary to ensure coverage of the proper coating thickness.

3. Limited Access is defined as a location where the physical characteristics or configuration of the structure restricts the use of a surface preparation or paint application tool at that location. A location is not considered Limited Access if additional time will allow for the proper cleaning or

painting of the area, or if commercially available tools are available to clean or paint the area (e.g., angle nozzles or short nozzles in place of traditional long nozzles for blast cleaning).

4. Whenever possible, move all containment system attachments and connections to existing steel to allow cleaning and application of all 3 coats of paint to these areas as specified by the contract requirements.
5. Maintain, calibrate, and adjust the thickness measuring instrument and take measurements in conformance with SSPC-PA 2.
6. Apply stripe coating after the application and cure of the previous full coat. Apply stripe coats using brush, dauber, or roller 1-inch around all edges, corners, lattice, angles, rivets, bolts, nuts, washers, welds, sharp and or thin edges, in between built-up members, top face of top flange of girders with cast-in place concrete decks prior to full application of the prime coat and intermediate coat.
7. Before stripe coating the intermediate coat, apply a 100 percent-solids rust-penetrating sealer to the following areas:
   a. all crevices 1/2-inch or less;
   b. to rivets, bolts and nuts;
   c. between built-up members; and
   d. where pack rust occurs.

   Use only a sealer that compliments the chosen/approved NEPCOAT system recommended by the specific Coating Manufacturer and does not void the warranty.
8. Before the finish coat, use a paintable caulk to seal:
   a. all crevices 1/2-inch or less;
   b. to rivets, bolts and nuts;
   c. between built up members;
   d. interface of steel and concrete surfaces; and
   e. where pack rust occurs.
9. Ensure that each coat is free of shadow-through, skips, misses, debris and thin or heavy coating thickness. Repair defects prior to application of the next coat. Keep the surface to be coated dust-free during painting operations and protect newly coated surfaces from the cleaning operations. When a previously cleaned or painted area becomes soiled, contaminated, or rusted, reclean the area to the specified condition and recoat as directed by the engineer.
10. Apply each coat within 14-days after the prior coat, unless approved in writing by the paint manufacturer. If the recoat window is exceeded, reclean the surface as approved by the paint manufacturer and the engineer.
11. At project completion, all beams shall have a smooth and uniform appearance throughout. Should a fascia have runs, sags, heavy film build, blisters, bubbles, orange peel or other coating defect which does not give the appearance of a smooth uniform surface, reclean and paint specific areas or the entire fascia as directed by the engineer.

G. Control of Overspray and Spills.

1. Up to 2-inches of overspray will be permitted onto the adjacent surface of the bridge deck next to the top flange. No other overspray will be permitted.
2. Whenever the method of protection fails to function at the required level of efficiency, immediately suspend all operations except those associated with minimizing adverse impact to the environment. Do not resume operations until modifications have been made to correct the cause of the failure. It is the responsibility of the contractor to correct all damage resulting from overspray during cleaning and painting operations.

H. Final Identification.

1. At the completion of the painting work, stencil, in 3-inch 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

   MAR 2013

616.3.7 Methods for Assessing Emissions.

A. Monitor the site in accordance with the approved EPPA as per Section 616.3.1.H.

B. SSPC Level 1 Visible Emissions. The following Level 1 visible emissions criteria apply when paint is disturbed by dry methods such as blast cleaning or power tool cleaning. Level 1 Emissions are defined as random visible emissions of a cumulative duration of no more than 1 percent of the workday or approximately 5 minutes in an 8-hour day. Level 1 is required for all structures. The contractor's QC person or Competent Person in the case of toxic metals projects, shall perform at least two 15-minute documented observations during each work shift. In addition to the 15-minute observations, routinely observe the work area. Immediately report unacceptable emissions to QC or supervisory personnel, to the Competent Person in the case of toxic metals projects, and to the engineer. When unacceptable emissions are detected, locate and immediately correct the source of the emissions. Retain the records on site and make them available to the engineer.

C. Ambient Air Monitoring.

1. Deploy ambient air monitoring when the coatings are being disturbed by abrasive blast cleaning or contain toxic metals, or whenever the paint removal operations are located within 500-feet of homes, schools, parks, businesses, shopping areas, pedestrian facilities, or similar areas of public exposure. Start monitoring no earlier than 1/2-hour before blast cleaning starts and run for the entire duration of the cleaning activity or 7-hours whichever is greater.

   a. Abrasive Blast Cleaning.

      i. Begin daily ambient air monitoring at each structure 1-day prior to beginning work and during the first 10-days of productive abrasive blast cleaning operations. When the results indicate that the containment is controlling emissions, full time monitoring may be discontinued unless otherwise directed. However, repeat monitoring for 2 consecutive days every month thereafter during the work shift while blast cleaning or other dust producing operations are underway.

ii. When the results of the original 10-days of monitoring or the periodic monthly tests are unacceptable, continue full time monitoring. Monthly monitoring may be initiated or resumed only when approved, and only after the results of the testing indicates that the containment is controlling emissions.

iii. Resume full time monitoring when unacceptable visible emissions or residues are observed on the ground or water.

b. Hand and Power Tool Cleaning.

i. Begin daily ambient air monitoring at each structure 1-day prior to beginning work and during the first 5-days of hand and power tool cleaning. When the results indicate that the containment is controlling emissions, full time monitoring may be discontinued unless otherwise directed. Resume monitoring when unacceptable visible emissions or residues are observed on the ground or water.

c. Monitor Placement and Reporting.

i. Place total suspended particulate (TSP) monitors in areas of potential public exposure (e.g., homes, schools, parks, businesses, shopping areas, or pedestrian facilities) that are within 500-feet of each project site during cleaning operations in conformance with Method D of SSPC Guide 6. Analyze all TSP monitoring samples using Method 40 CFR 50 Appendix B and G by a laboratory approved by the American Industrial Hygiene Association.

ii. The CIH/CSP shall use an Adjusted Daily Allowance (ADA) as described in SSPC Guide 6 (not an average daily allowance) for evaluating the TSP monitoring results. Provide test results as per Section 616.3.1.B.3.

C. Removal of Visible Project Debris. At the end of the shift each day and upon completion of all project activities, clean the surrounding property, structures, and the entire project area of visible project debris.

616.3.8 Waste Collection and Handling.

A. Collect, handle, test, store, transport, and dispose of waste materials in accordance with the approved Waste Handling Plan of Action as per Section 616.3.1.I. Consider all waste generated from existing paint systems and from abrasive blast cleaning as hazardous waste when collected and handled, unless tests conducted as specified in the Toxicity Characteristic Leaching Procedure (TCLP), EPA Method 1311 prove otherwise.

B. Materials to be Collected from Containment System by Method of Preparation.

1. Pressure washing.

a. When pressure washing newly installed steel coated only with inorganic zinc primer, the surfaces may be washed without containment or collection of the water. Prevent spray and runoff water from entering traveled areas such as roadways, walkways, and railroads.

b. Whenever pressure washing is being performed on other painted surfaces, prevent paint chips from falling into rivers, streams, wetlands, wetland buffers, or other bodies of water, and when specified, from falling onto the ground. Should inadvertent spills or releases of paint chips occur, clean them up before the end of the shift, or immediately if directed.

i. When pressure washing paint containing toxic metals or inorganic zinc/vinyl systems, use a containment system that meets SSPC Class 2W. Collect and dispose of all wash water and

debris as per the applicable regulations, respectively. Prevent paint chips from falling onto the ground.

ii. When pressure washing all other systems (systems other than inorganic zinc, inorganic zinc/vinyl, or systems that contain toxic metals), collect all dislodged paint chips, but the water need not be captured. When working over ground, chips may be collected from the ground in lieu of utilizing containment screens, provided all chips are collected before the end of the shift.

2. Power Tool and Hand Tool Cleaning.

a. Prevent paint chips from falling onto the ground or into rivers, streams, wetlands, wetland buffers, or other bodies of water. Should inadvertent spills or releases of paint chips occur, clean them up before the end of the shift, or immediately if directed.

i. If paint system contains toxic metals, use a containment system for open power tool cleaning that meets SSPC Class 2P. Dispose of collected paint chips and debris per the applicable regulations.

ii. If paint system does not contain toxic metals, use a containment system for open power tool cleaning that meets SSPC Class 3P. Dispose of collected paint chips and debris per the applicable regulations.

iii. For roadway joints and other small areas approved by the engineer, High Efficiency Particulate Air (HEPA) filter vacuum shrouded power tools may be used in lieu of containment in areas of paint containing toxic or nontoxic metals. Vacuum-shrouded power tools may eliminate the need for containment if it can be demonstrated that all paint chips and debris are sufficiently collected by the vacuum.

3. Total Paint Removal by Abrasive Blast Cleaning.

a. Regardless of the presence of toxic metals, prevent paint chips and abrasive blasting media from falling onto the ground or into rivers, streams, wetlands, wetland buffers, or other bodies of water by use a containment system that meets SSPC Class 2A. Should inadvertent spills or releases of abrasives or paint chips occur, clean them up before the end of the shift, or immediately if directed.

4. When cleaning structures over water, provide a skimming boom, consisting of a float with a skirt or other approved system, for emergency backup collection of floating debris.

B. Collection and Storage of Hazardous and Non-Hazardous Waste.

1. All waste discharged and collected from the containment system must be protected in a manner 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, non-hazardous waste, and solid waste.

2. Each day, collect and contain waste material in sealed 55-gallon open-head-type drums that meet International Compliance Commission Specification 17-H. All drums must be in like new condition and approved for use by the engineer. Label each drum including Bridge number, Contract number, Contractor's name, contents, and the date when waste accumulation in the drum begins.

a. Label drums containing hazardous waste with the words "HAZARDOUS WASTE" and tag in accordance with all State regulations. Keep no more than 29 drums of hazardous material at the site of each bridge.

b. Label drums containing non-hazardous waste with the words "NON-HAZARDOUS WASTE" and tag in accordance with all State regulations. Keep no more than 29 drums of non-hazardous material at the site of each bridge.

3. Dispose of filters from abrasive blasting equipment and vacuum power tools used to remove hazardous and non-hazardous paint waste in appropriate drums with other collected waste. At the end of the contract, dispose of all such filters from equipment used on the project and place in drums with other hazardous waste for proper disposal.

4. Store all drums on pallets on top of a tarp or plastic placed below the pallet and then cover the top of the drums with a tarp or plastic when not in an active filling process.

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. Utilize a storage site and an accumulation site capable of preventing the migration of toxic metals contaminated waste material into the environment. Provide both areas with protection from vandalism and unauthorized access.

7. Sampling and Testing.

a. The CIH/CSP, or an employee working under the direct supervision of the CIH/CSP, shall take at least 4 samples of the accumulated residues of each waste stream collected at each structure or a sample from every third drum, whichever is greater. Consider sampling to be random and representative. Do not allow waste to accumulate for more than 30-days before sampling.

b. Sample drums of other wastes; such as solvent contaminated rags, disposable protective clothing, disposed dust collector filters, and other contaminated substances; individually and test appropriately.

c. Deliver the representative samples to a laboratory approved by the Department for testing according to the EPA SW846, Test Method 1311, Toxicity Characteristic Leaching Procedure (TCLP).

d. Test the wastewater collected from bridge pressure washing and from hygiene facilities for toxic metals. Perform tests using EPA Method 6010 by a laboratory approved by the American Board of Industrial Hygiene.

e. Analyze samples for TCLP as outlined in State Department of Natural Resources and Environmental Control (DNREC) and the EPA Test Procedure Manual, SW-846 for all RCRA 8 Metals. The disposal method will be based on the results of these analyses.

f. Take additional samples if the average test results exceed 3.5 mg/l for lead or exceed the threshold levels for other toxic metals listed by the EPA.

g. Provide test results as per Section 616.3.1.B.3.

C. Waste Transportation and Disposal.

1. Hazardous waste.
   a. Prepare a manifest, containing the information stipulated in and required by State regulations for hazardous waste to be transported from the approved temporary storage site. Provide copies of the manifests to the Department.
   b. Dispose of waste containing more than the threshold value by the TCLP test, including the confidence interval, as hazardous waste in accordance with 40 CFR Part 261 Identification and Listing of Hazardous Waste.
   c. 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.
2. Non-hazardous waste.
   a. Waste containing less than the threshold value by the TCLP test, including the confidence interval, may be disposed of as an industrial waste at a landfill permitted to accept this material. Dispose of all waste according to Federal, State, County, and local regulations.

616.3.9 Defective Work.

A. Neither conditions during application nor laboratory acceptance of paint removes the contractor's responsibility of obtaining a satisfactory paint system. When rusting occurs or a paint coat lifts, blisters, wrinkles, shows evidence of having been applied under unfavorable conditions, the workmanship is poor, impure or unauthorized paint has been used, or for any other reason the painting is unsatisfactory; remove the affected paint and thoroughly clean the steel and recoat. Ensure that there is a uniform appearance throughout the structure.

B. When coatings are damaged by the contractor's operations, notify the Department to determine the methods of cleaning and painting to be used for repairs.

616.3.10 Coating System Warranty and Guarantee.

A. Warranty Bond.
   1. Submit a 2-year warranty bond to the Department at final acceptance of the project to correct any failures during the 2-year project warranty and guarantee period.
   2. Provide a warranty bond equal to 100 percent of the total contract quantity paid for preparation, cleaning, painting, and maintenance of traffic.
   3. The existence of the warranty bond does not relieve the contractor of responsibility to repair all required areas within the warranty period.
   4. The Department will retain the bond for 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.

B. Warranty Evaluation Review.
   1. During the month before the end of the warranty period, the engineer will inspect the bridge thoroughly for failures of the coating system. Perform this semifinal warranty inspection jointly with the Department, with equipment supplied by the contractor. Use OSHA-approved, vehicle-mounted inspection equipment, and provide access to all areas of the structure. Provide traffic control and required signing in accordance with the DelDOT MUTCD during the semifinal

warranty inspection. Submit the plan for inspection access and traffic control to the Department for approval prior to beginning the semi-final inspection.

2. The Department will notify the contractor in writing of all failures of the coating system discovered within the warranty period. The Department will send this notice by registered mail or other special delivery service, with cost prepaid and return-receipt-requested, to the contractor.
3. Respond within 30 days of said notice to acknowledge receipt and submit a plan of action to complete the repairs.
4. Inspect and test the alleged failure and coatings without interfering with the Department activities.

C. Failure of the Coating System Definitions.

1. 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.
2. 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.
3. Sub-film corrosion determined visually by the engineer and verified by destruction of coating in disputed areas.
4. 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.
5. Erosion of the film at a rate of 2 percent of the coating surface of a contiguous area per year or greater determined by engineer measuring actual areas of failures.
6. Non-uniformity of topcoat color such as patches, streaks, chalking, or patterns discernible from a distance of 10 feet or greater, that washing does not eliminate.
7. Failure of the coating system deemed to have occurred if the sum of the failures described above is greater than 2 percent of the coating surface of a single contiguous area. Use “Guide to SSPC-VIS 2” as a guide in determining failure.
8. A contiguous area is defined as:
   a. Each face of each stringer beam in each span, including top flange and top of bottom flange;
   b. Each bottom of the lower flange in each span;
   c. Each diaphragm; or
   d. Each bearing.

D. Warranty Repair Requirements.

1. Within 120-days after receipt of written notice, correct all failures in materials and workmanship that develop within the warranty period. The Department may grant variations to the 120-day requirement if the contractor encounters impediments of permits, traffic control, weather, construction, or other state projects not under the contractor’s control. The engineer may recommend the granting of extensions.

2. Correct and repair all damage to other work or property of the State of Delaware caused by defective materials, equipment, or workmanship when performing warranty repairs. The engineer will determine the degree of the repair or corrective procedure.
3. Correct and repair the coating system to the performance requirements of the original contract, under the warranty. The decision of the extent of repairs or replacements will result from a cooperative assessment effort between by the engineer and the contractor.
4. Overlap recoated areas onto a properly performing adjacent coating system. Provide a cosmetic topcoat to promote a uniform color and appearance of the painted structure on fascia girders or beams or areas visible to the public. This will only occur if a failure or repair creates a discontinuity of the visible appearance, as determined by the engineer.

E. Exclusions to the Warranty and Guarantee.

1. Excluded from the warranty and guarantee are damages that occur after acceptance of the coating system that are not a direct result of normal usage. Exclusions also include areas agreed to in writing by both the contractor and the engineer before the initiation of the project.
2. The foregoing guarantee and obligations shall not deprive the State of Delaware of any action, right, or remedy otherwise available for breach of the provisions of the contract. Ensure that the periods referred to above do not define a limitation on the time in which the Department may pursue such other action, right, or remedy.

616.4 Method of Measurement.

A. The Department will not measure the quantity of shop painting of new steel.

B. The Department will measure the quantity of field painting of existing steel in number of square feet of steel surface cleaned, painted, and accepted. Multiple coats will not be measured more than once. If this work is paid for by lump sum, this will not be measured.

C. The Department will measure the quantity of existing hazardous steel coating in number of square feet of existing hazardous steel coating collected, tested, and disposed of. If this work is paid for by lump sum, this will not be measured.

616.5 Basis of Payment.

A. Price and payment for shop painting of new steel is incidental to the applicable steel structures item and will constitute full compensation for:

1. Providing and installing all materials;
2. providing protection against damage during paint application;
3. re-establishing project standards, if necessary;
   a. re-cleaning when primer is not applied within 8 hours of initial cleaning;
   b. after use of unauthorized solvents;
   c. after application of paint containing unauthorized thinners;
   d. after application of paint to contaminated surfaces and;
   e. after application of paint without QA approval;
   f. after application of paint contrary to the requirements of this section.

B. Price and payment for cleaning and painting existing steel will constitute full compensation for:

1. Removing existing coating;
2. Providing the containment system;
3. Providing artificial climate controls, if necessary;
4. Preparing the surface;
5. Providing and installing all materials;
6. Providing protection against damage during paint application;
7. Re-establishing project standards, if necessary;
   a. re-cleaning when primer is not applied within 8 hours of initial cleaning;
   b. re-cleaning areas of previously cleaned steel that become soiled, rusted or contaminated prior to painting;
   c. after use of unauthorized solvents;
   d. after application of paint containing unauthorized thinners;
   e. after application of paint to contaminated surfaces;
   f. after application of paint without QA approval;
   g. correction, to existing conditions, of damage caused by overspray; and
   h. after application of paint contrary to the requirements of this section

C. Price and payment for removal and disposal of hazardous material will constitute full compensation for:

1. Providing and installing all materials;
2. Working drawings, plans of action, and consultant services;
3. Collection, stabilization, temporary storage, transportation and disposal of all waste material;
4. Air, soil and water monitoring services;
5. Testing materials for contaminants;
6. Providing hygiene facilities and protective equipment to the workers and the Department's employees; and
7. Revisions and resubmissions of the containment plan and systems required during the execution of the work.

D. The Department will consider costs for providing the coating warranty as incidental to the coating or painting items in the contract.

ITEM	DESCRIPTION	UNIT
616000	CLEANING AND PAINTING EXISTING STEEL	LS
616001	CLEANING AND PAINTING EXISTING STEEL	SF
616003	TESTING AND DISPOSAL OF EXISTING HAZARDOUS STEEL COATING	LS
616004	TESTING AND DISPOSAL OF EXISTING HAZARDOUS STEEL COATING	SF

SECTION 617 — STEEL SIGN STRUCTURES

617.1 Description.

This work consists of providing, fabricating, and erecting steel sign structures.

617.2 Materials.

A. Cantilever, Center Mount, Monopipe, or Overhead with Single Plane Truss.

1. Columns, Struts, and Truss Chords. Section 1039.8.E
2. Truss Webs and Truss Verticals. ASTM A53, Grade B, Type E or S for Tubular Members; or Section 1039.8 for pipe and tubing.
3. Steel Angles, Shapes, Plates and Backing Rings. Section 1039.1

B. Overhead with Tri-Chord or Box-Shaped Truss. Sections 617.2.A.1 and 617.2.A.2.

C. Fabricated Structural Steel. Section 1039.1

D. U-bolts, Nuts, Washers, and Direct Tension Indicators. Section 1039.2

E. High-Strength Fasteners. Section 1039.3

F. Anchor Bolts, Nuts, and Washers. Section 1039.4

G. Galvanizing Section 1039.10

H. Galvanized steel screen - 1/2-inch by 1/2-inch mesh and 0.063-inch diameter galvanized steel wires.

617.3 Construction.

A. Submittals.

1. Submit documentation in accordance with Section 615.3.A.
2. Submit working drawings in accordance with Section 615.3.A. On fabrication drawings, identify the splice and weld locations, type, size, process, and method and procedure for non-destructive testing. Field-verify dimensions before submitting working drawings.
3. Submit erection plan in accordance with Section 615.3.A.
4. Obtain the engineer’s approval for alternate designs. Provide structurally equivalent alternate designs. The engineer may reject alternate designs for any reason.

B. Fabricate in accordance with Section 615.3.B., except as noted below:

1. For welds, comply with AWS D1.1 structural welding code as well as the additional requirements of AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, Section 5.14.
2. Perform and evaluate non-destructive weld testing according to cyclically loaded non- tubular tension criteria.
   a. The Department's plant inspector will select weld locations and weldments for testing.

b. 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:

(1) Flange splice plate to the truss chords;

(2) base plate to the tower columns;

(3) connection plate to the chords or columns;

(4) CJP weld on truss seat plates; and

(5) CJP longitudinal seam weld on cantilever and center-mount sleeves.

(6) If a defect occurs that warrants rejection, test 100 percent of the weld on that element.

ii. 100 percent of the length of CJP groove welds on monopipe structures.

iii. 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.

(1) If any defect is found that warrants rejection, double the testing frequency until no defects warranting rejection are found.

c. Perform the following minimum magnetic particle inspection (MT) of fillet welds and partial joint penetration (PJP) groove welds.

i. For intermediate member connections, perform MT on 100 percent of the weldment length on at least 25 percent of the total number of connections on trusses and towers.

(1) If any defect is found that warrants rejection, double the testing frequency until no defects warranting rejection are found.

ii. For 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, perform MT on a minimum of 25 percent of the total length of each weld.

(1) If a defect occurs that warrants rejection, test 100 percent of the weld on that element.

iii. For welds attaching handhole frames to columns, MT 100 percent of the length of each weld.

iv. For all other connections, MT 100 percent of the weldments on at least 10 percent of the total number of connections.

(1) If any defect is found that warrants rejection, double the testing frequency until no defects warranting rejection are found.

d. Perform ultrasonic inspection of the groove weld prior to welding the 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.

e. If necessary repair base connection welds 1 time. Re-test all repairs. If more than 1 repair is necessary, obtain approval from the engineer before proceeding.

3. Fabricate backing rings as a continuous ring or butt-welded with a full-penetration weld.

4. Form columns for monopipe sign structures to the radii shown in the contract 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 steel members and fasteners in accordance with Section 1039.10.
   b. Fabricate steel sign structure into the largest practical unit before galvanizing. Do not fabricate steel sign structure until obtaining approval of splice locations.

C. Excavate and construct the foundations in accordance with the contract. Slope top of sign pedestal 4 percent from center to near edges for drainage.

1. Construct drilled shafts in accordance with Section 606.
2. Construct spread footings in accordance with Sections 207, 209, 610, and 611.
3. Anchor Bolts.
   a. Use steel templates provided by the fabricator to set the elevation and alignment of tower base anchor bolts. Brace the bolts against movement before placement of concrete.
   b. Pretension anchor bolts according to the following procedure:
      i. Verify that the nuts will turn onto the bolts past the elevation corresponding to the bottom of each in-place leveling nut. Ensure that it is possible for 1 person, using a 12-inch-long wrench, to back the nuts off 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 if more than 24-hours elapses before installing the leveling nuts, or if the anchor bolts and leveling nuts become wet between lubrication and installation.
      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 with 1 washer corresponding to each anchor bolt.
      v. Install the base plate atop the leveling nuts, place structural washers on top of the base plate, with 1 washer corresponding to each anchor bolt, place 1 direct tension indicator on each washer, and turn the top nuts onto the anchor bolts.
      vi. Tighten top nuts to a snug-tight condition in a star pattern. The definition of snug-tight is the maximum nut rotation resulting from 1 person using a 12-inch-long wrench or equivalent. A star tightening pattern is when nuts on opposite or near-opposite sides of the bolt circle are successively tightened in a pattern resembling a star. 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 marking on 1 side with a corresponding reference mark on the base plate at each bolt. Incrementally turn the top nuts using a star pattern until achieving the required nut rotation in accordance with Section 615, Table 615.3-4. Turn the nuts in at least 2, full tightening cycles. After tightening, verify the nut rotation.
      ix. Tighten second nut 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 the face of the nut after installation of column.

4. Use a galvanized steel screen to seal the gap between the base plate and the foundation. Cover the entire gap with a wire screen. Ensure that the bottom horizontal wire remains in full contact with the surface of the concrete foundation and the top horizontal wire does not extend beyond the top surface of the base plate. Do not allow vertical screen wires to extend beyond the top and bottom horizontal wires of the screen. Use 1 continuous section of screen with only 1 overlapping splice where the ends come together. Overlap the layers 3-inches minimum. Attach the screen to the vertical side of the base plate with No. 8, 1/2-inch long self-tapping stainless-steel screws with 1/4-inch inside diameter stainless-steel washers. Drill pilot holes into the base plate to facilitate screw installation. Install screws on 9-inch centers maximum with at least 1 screw installed through the overlapping splice to clamp the layers together. Clamp the overlapping splice layers together just above the concrete foundation. Clamp with an all-stainless-steel fastener assembly consisting of a No. 8, 5/8-inch long machine screw, a nut, two 1/4-inch inside diameter flat washers, and a lock washer. Clamp the screen layers between the flat washers.

617.4 Method of Measurement.

A. The Department will not measure the quantity of steel sign structures placed and accepted.

617.5 Basis of Payment.

A. Price and payment constitute full compensation for:

1. Submittals;
2. alternate designs;
3. providing materials;
4. fabrication;
5. welds;
6. transporting;
7. assembly;
8. installing steel sign structures;
9. hardware; and
10. repairs and preparation for galvanization.

B. The Department will pay for:

1. Drilled shafts in accordance with Section 606;
2. reinforcement in accordance with Section 611; and
3. sign panels in accordance with Sections 818 and 822.

C. 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. Submit the breakout sheet for lump sum items in accordance with Section 109.

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
617005	STEEL SIGN STRUCTURE, CENTER MOUNT	LS

SECTION 619 — STONE AND BRICK MASONRY

619.1 Description.

This work consists of providing, constructing, reconstructing, or repairing stone or brick masonry.

619.2 Materials.

A. Mortar Section 1047.6

B. Provide stone of the type and dimensions specified in the contract and in accordance with Section 1040. Provide stone free of iron content significant enough to cause rust-staining of the stone or materials below the stone.

1. For repair or reconstruction, use salvaged stone from the site or provide stone to match existing stone types, colors, sizes, shapes, and patterns.

C. Provide brick in accordance with Section 1040.

1. For repair or reconstruction, provide brick to match existing stone types, colors, sizes, shapes, and patterns as closely as possible.

D. Provide steel wall ties or dovetails hot-dipped galvanized in accordance with Section 1039.10 or stainless steel in accordance with AASHTO M163.

619.3 Construction.

A. Submittals.

1. Submit the masonry contractor qualifications verifying successful completion of at least 3 similar projects within the last 5-years. Include a brief description of each project and the owner's contact person's name and current phone number for each project listed.

2. Submit samples of stone and brick for approval before starting work.

B. Place mortar to form a firm bond. Dispose of mortar not used within 30-minutes after adding water. Do not re-temper mortar.

C. Placing Masonry

1. Do not perform any masonry work when the temperature is below 40 degrees F.

2. Lay the stone to the wall pattern shown in the contract. Wet the stone before laying in mortar. Fill all joints with mortar and finish as work progresses. Make mortar joints 1-inch to 1 1/2-inches thick.

3. Lay bricks using the shove-joint method to bed the bricks into the mortar. Do not use buttered or plastered joints. Arrange all brick headers and stretchers in order to bond the mass with alternate courses breaking joints. Fill all joints with mortar and finish as the work progresses. Make 1/4-inch to 1/2-inch thick joints. Do not use spalls or bats, except for shaping irregular openings or when unavoidable to finish out a course. If the engineer approves the use of spalls or bats, place full bricks at the corners and place bats in the interior of the course.

D. After constructing the masonry, clean the entire area of all efflorescence, mortar, scars, or spots to present a natural color. Clean the area with water. Treat with a solution of 1 percent hydrochloric acid and then wash again with water a final time. When cleaning stone masonry with

the solution, take care to notice any deteriorating reaction. If a reaction is noticed, stop using the solution, wash the treated area immediately and clean the stone masonry to present the natural color.

E. Before 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. Wet joints before applying the mortar. Mix and place mortar in accordance with Section 619.3.B. Use only mortar that matches the color of the existing mortar. In hot or dry weather, shield pointing work from the sun and keep wet for a period of 3-days after completion.

F. Exercise care when handling existing masonry planned for reconstruction. Avoid dropping, breaking or scarring the stones. 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.

619.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Stone masonry by the square foot placed and accepted.
2. Brick masonry by the square foot placed and accepted.
3. Pointing masonry by the linear feet of joints pointed and accepted.
4. Reconstructing existing stone masonry by the square foot or cubic foot of existing stone masonry reconstructed and accepted.
5. Reconstructing existing brick masonry by the square foot or cubic foot of existing brick masonry reconstructed and accepted.

619.5 Basis of Payment.

A. Price and payment for stone or brick masonry will constitute full compensation for:

1. Submittals;
2. samples;
3. providing;
4. placing;
5. cleaning stone or brick masonry; and
6. disposal of surplus materials.

B. Price and payment for pointing existing masonry will constitute full compensation for providing all materials and pointing the joints as described in this specification.

C. Price and payment for reconstructing stone or brick masonry will constitute full compensation for removing and stockpiling existing stone or brick, disposing of unsuitable materials, and providing, placing, and cleaning stone or brick masonry.

D. The Department will pay for excavating and backfilling in accordance with Section 207.

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

SECTION 621 — WOOD STRUCTURES

621.1 Description.

This work consists of constructing wood structures and the wood portions of composite structures.

621.2 Materials.

A. Wood Section 1041

621.3 Construction.

A. Cure the wood before fabrication. Store wood after fabrication in a manner that prevents changes in the dimensions of the members before assembly. Reject wood that shrinks during storage, causing predrilled grooves for split rings, plate size, or bolt hole spacing to change.

B. Stack lumber and timber to prevent warping. Stack untreated material on supports at least 12-inches above the ground and open-stacked. Stack treated material on supports at least 12-inches above the ground surface and close-stacked. Provide cover to protect materials from the weather.

C. Treated Wood.

1. To avoid damaging treated timber, handle with web slings. Provide corner protectors when using metal bands to bundle members.
2. As much as is practical, cut, frame, and bore treated timbers before treatment.
3. Field-treat as necessary in accordance with Section 1041.4.E. After treatment, plug holes not filled with bolts or other items, with preservative-treated plugs flush with the surface.

D. Connectors and fasteners.

1. 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 are 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 before preservative treatment. Drill bolt holes perpendicular to the face of the member.
2. For fastenings, drill 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 no 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. Countersink hardware when required to have smooth and flush surfaces. Treat all recesses formed for countersinking in treated timber, in accordance with Section 1041.4.E.

E. Cut and frame lumber and timber to a close fit with joints bearing evenly over the entire contact surfaces without requiring shims. The engineer will reject open joints. Ensure that all framing is true and exact. Set the nail heads flush with the surface of the wood. The engineer may consider hammer marks in wood surfaces as evidence of poor work quality and cause for removing the responsible crew member.

F. 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 2-inches off-center of the pile to avoid conflicts with other hardware.

G. For wood abutment and wingwall backing, place wood backing with horizontal members level and secured directly to the pile or nailing block. Secure horizontal backing with a minimum of 2 lag screws with washers at least 3/8-inch in diameter for each 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 2 lag screws with washers at least 3/8-inch in diameter to each of the top 2 rows of horizontal backing. Place the lag screws a minimum of 2-inches into the horizontal backing but do not extend through the horizontal backing.

H. Place bolt bracing through the pile or cap at the ends and at intermediate intersections using a bolt of no less than 5/8-inch in diameter. Use bracing long enough to provide a minimum distance of 8 inches between the outside bolt and the end of the brace.

I. Cut stringers at bearings to create full bearing of the stringer. Place in a position that keeps knots near edges 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. Stagger the joints when stringers are 2 panels in length. Fasten all stringers by drift bolting. Place cross-bridging or blocking at the center of each span. Frame the cross-bridging between stringers and toenail with at least 2 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. Use planks surfaced on 4 sides for decking. 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 the planks 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 ensuring that no 2 adjacent planks vary in thickness by more than 1/8-inch. Provide a finished surface free of defects.

K. Prepare glue-laminated deck panels in accordance with Section 1041.3 and apply pressure preservative treatment in accordance with Section 1041.4.A. Apply a preservative treatment to untreated field-cut or drilled areas. Plane bottom of deck panels only. Leave the top of the deck rough to ensure proper bonding with bituminous material. Remove excess oil by absorption before paving. Avoid damaging panels when handling and transporting. Protect the edges from damage and provide proper dunnage for deck panels during storage.

L. Frame and erect wheel guards true to line and grade. Use wheel guards, rails, and rail posts surfaced on 4 sides. Lay wheel guards in sections no less than 12-feet long, except where necessary to match expansion joints or end joints.

M. Use horizontal railing members that are smooth and free of splinters in potential pedestrian areas.

621.4 Method of Measurement.

A. The Department's measurement of lumber and timber and of glue-laminated girders and beams will only include material that is a part of the completed and accepted work. The Department will measure material used for temporary works in accordance with Section 604.

B. The Department will measure timber and lumber by the number of MFBM complete in place and accepted, computed from the actual dimensions and actual lengths.

C. The Department will measure glue-laminated girders, beams, and deck panels using the finished cross-sectional dimensions and actual lengths. The Department will measure quantities for glue-laminated girders, beams, and deck panels by the number of MFBM placed and accepted.

D. The Department will not measure timber piles, timber sheet pile, railing, or other items for which the Department will provide separate payment.

621.5 Basis of Payment.

A. Price and payment for wood structures constitute full compensation for providing all materials, applying preservative treatment, and placing all material.

B. The Department will pay for:

1. Timber used in temporary works in accordance with Section 604;
2. Timber piles in accordance with Section 605;
3. Timber sheet piles in accordance with Section 608; and
4. Timber railing under Sections 720 and 721.

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

SECTION 623 — BEARING DEVICES

623.1 Description.

This work consists of fabricating, providing, and installing bearing devices.

623.2 Materials.

A. 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.	Dowels	Section 1037
C.	Anchor Bolts	Section 1039
D.	Non-Shrink Grout	Section 1047.2
E.	Epoxy Grout	Section 1047.4
F.	Bearing Grease	Waterproof, NLGI 2

623.3 Construction.

A. Manufacture and test bearings in accordance with the current edition of the AASHTO LRFD Bridge Construction Specifications, Chapter 18.

B. Submittals.

1. Prepare and submit working drawings for the bearings. Show all details of the bearings and of the materials proposed for use. Provide the seal of a professional Delaware engineer. Do not begin fabrication until receiving the engineer's approval of the drawings. Include the following in the working drawings:

   a. The manufacturer's name, location of the fabrication plant, and the name of the representative responsible for coordinating production, inspection, sampling, and testing.

   b. The total quantity of each kind of fixed, guided expansion, or non-guided expansion bearing required grouped first according to load range type and then grouped by actual design capacity.

   c. The type of materials used for all bearing elements.

   d. A description and details for welding processes used in the bearing manufacture that do not conform to the approved processes of the specified AASHTO/AWS D1.5 Bridge Welding Code.

   e. The painting or coating requirements.

   f. Plan, section, and elevation views showing all relative dimensions and alignment of each type of bearing.

   g. Complete design calculations verifying conformance with the contract including vertical and horizontal load, rotation, and movement capacity; and maximum design coefficient of friction as noted in the contract.

   h. The installation scheme showing bearing preset details and anchorage details.

2. If the contractor proposes an alternate design, submit supporting calculations certified by a registered Delaware professional engineer. Design bearings in accordance with the specified edition of the AASHTO LRFD Bridge Design Specifications, Chapter 14. For steel-reinforced elastomeric bearings, design using Method B.

C. Packaging, handling, and storage.

1. Before shipment from the point of manufacture, package bearings to protect against damage during shipment and storage.
2. Identify each bearing by marking the location and orientation on the top of the bearing. Bolt, strap, or otherwise fasten the components to prevent movement.
3. Store 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 for inspection by the engineer or approved by the engineer for installation. If the contract requires dismantling at the site, open or dismantle the bearings only under the direct supervision of the manufacturer's representative.

D. 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 0.5 percent of the nominal dimension for steel reinforced bearings and 1 percent of the nominal dimension for others. Place these bearings within 0.01 radians. Use grout or approved equal 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 bearing plates only if there is 1 1/2-inches of steel between the weld and the elastomer. Do not subject the elastomer or bond to temperatures in excess of 390 degrees F.
3. For new structural steel, vulcanize the bearing to the sole plate before 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. Clean the bridge seat before applying the adhesive.

E. Pot and disc bearings.

1. Install bearings in accordance with the contract and working drawings. Ensure that a technical representative of the bearing manufacturer is on-site for the first bearing installation and 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 verify that the components are level and parallel to within 0.03 inch per foot.
3. If the bearings do not meet the tolerances above, submit a plan to correct deviations.

F. Anchor bolts.

1. Provide swedged or threaded anchor bolts to ensure a secure grip on the material used to embed the bolts in the holes.

2. Either cast-in-place or epoxy 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, drill out the existing bolts. 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 a variation from mean temperature of the superstructure at the time of setting. Anticipate lengthening of the bottom chord or bottom flange, resulting from dead load after setting, so that the anchor bolts at expansion bearings will center in the 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.

G. Cleaning and greasing bearings.

1. Clean bearings before greasing using high-pressure water flushing at 3,000 PSI.
2. Remove remaining debris by hand-chipping.
3. Allow bearings time to fully dry before applying grease.
4. Apply grease at sufficient pressure and rate such that it covers the contact surface completely.
5. Ensure a final film of 1/16-inch minimum on the exposed area of bearings.

623.4 Method of Measurement.

A. The Department will measure:

1. Bearing devices as the number of each bearing device placed and accepted.
2. Replaced anchor bolts as the number of each anchor bolt removed, replaced, and accepted.
3. Cleaning and greasing bridge bearings as the number of each bearing cleaned, greased, and accepted.

623.5 Basis of Payment.

A. Price and payment for bearings constitute full compensation for providing all materials, testing, cleaning, lubricating, and installing bearing devices.

B. Price and payment for replacing anchor bolts constitute full compensation for providing new anchor bolts, removing and disposing of existing anchor bolts, and installing anchor bolts.

C. Price and payment for cleaning and greasing bearings constitute full compensation for cleaning, disposing of debris, and greasing bearings.

ITEM	DESCRIPTION	UNIT
623000	ELASTOMERIC BEARINGS	EACH
623001	POT BEARINGS	EACH
623002	DISC BEARINGS	EACH
623003	REPLACE ANCHOR BOLTS	EACH

ITEM	DESCRIPTION	UNIT
623004	CLEAN AND GREASE BRIDGE BEARINGS	EACH
623005	STEEL REINFORCED ELASTOMERIC BEARINGS	EACH

SECTION 624 — JOINTS

624.1 Description.

This work consists of fabricating, providing, and installing joints and joint seals.

624.2 Materials.

A. Prefabricated Expansion Joint System

1. Galvanized Steel — Section 1039
2. Strip Seal — Section 1042.4.A

C. Closed-Cell Joint Seal — Section 1043

D. Asphaltic Plug Joint — Section 1042.B

E. Silicone Seal — ASTM D5893

F. Pre-compressed silicone coated, self-expanding foam bonded to joint substrate by adhesive.

624.3 Construction.

A. Submittals.

1. Provide a complete set of working drawings, in accordance with Section 105.4, before beginning fabrication. Include details and drawings of the steel elements, seals, and all other permanent elements fabricated as part of the joint system. 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 attend the initial installation of the respective joint system. A manufacturer's letter of certification as an approved installer may suffice instead of having a manufacturer's representative onsite. Qualifying personnel must oversee all operations.
3. Submit the qualifications of the contractor to verify successful completion of at least 3 separate similar projects with the same type of joint system within the last 5-years. Include a brief description of each project and the owner's contact person's name and current phone number for each project listed.

B. Prefabricated expansion joint system.

1. For rehabilitations, remove the existing joint and surrounding concrete in accordance with the contract. Repair concrete in accordance with Section 628, as required.
2. Unless approved otherwise, shop-assemble the prefabricated system as a unit and preset before shipment. Set the opening of the joint at the width required for the seal in accordance with the contract. Galvanize steel elements. Perform welding and steel cutting work in accordance with Section 615.
3. Protect joint materials and assemblies from damage. Support assemblies when stored at the job site to maintain true shape and alignment.

4. Install the prefabricated expansion joint system, including strip seal, steel extrusion, and application of adhesives, in accordance with the manufacturer's recommendations. Use tools for insertion of seals in accordance with the manufacturer’s recommendations.
5. Provide and install the strip seal in 1 piece for the full joint length.
6. Install deck joint assemblies to provide a smooth ride.

C. Strip seal gland replacement.

1. Remove the existing strip seal gland and adhesive.
2. Use an abrasive to blast clean the extrusion to remove all debris and loose material. Do not damage existing steel extrusions.
3. Install the prefabricated strip seal and apply adhesives in accordance with the manufacturer's recommendations.
4. Provide and install the strip seal in 1 piece for the full joint width.

D. Asphaltic plug joint.

1. During surface preparation and installation, provide qualified personnel on site to oversee and direct the operation for conformance with manufacturer's specifications for both the asphaltic and parapet joint seals.
2. Remove the concrete in the joint using saws and pneumatic hand tools. Remove all debris from the joint.
3. Repair spalled and defective concrete in accordance with Section 628.
4. Prepare the surface of the concrete substrates before receiving the joint material. Install the joint material in accordance with the manufacturer's recommendations.
5. Ensure that the steel plate sits squarely and does not rock on the concrete surfaces. If necessary, remove additional concrete and build up the joint using patch mortar to the required elevation.
6. After compaction, place lines of 4-inch tape 1-inch beyond the joint width on each side of the joint. 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.
7. Immediately after top-coating, spread an anti-skid material over the joint to eliminate material tracking.
8. In the event of a work stoppage, fill the cavity with cold-patch asphalt, in accordance with Section 1015.
9. After curing of the asphaltic joint material, seal the parapet joints along the traffic face of the parapet, in accordance with the manufacturer's surface preparation and installation procedures.

E. Silicone seal.

1. Remove and dispose of existing joint seal.
2. Abrasive-blast and prepare the surfaces of the armor and angles receiving the silicone seal in accordance with the manufacturer's instructions. Before installing round backer rod, blow joints clean with compressed air. Install the backer rod in a consistent, uniform placement at the proper depth below the bridge deck surface.

3. Install the silicone sealant as soon possible after backer rod placement.
4. Install the silicone sealant in accordance with the manufacturer's recommendations and to the shape and dimensions shown in the contract. Any failure of the sealed joint due to lack of adhesion or cohesion of joint material, improper or unsatisfactory workmanship, or damage by the contractor's operations will result in rejection. Repair the joint to the engineer's satisfaction.
5. Ensure that placement of the silicone seal is at least 1/4-inch below the riding surface.
6. After sealing a joint, remove 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 embed into the sealant.

F. Compression Seal.

1. Repair concrete spalls and cracks in accordance with Section 628.
2. Sand-blast surfaces of the joint receiving the compression seal in accordance with manufacturer's recommendations immediately before the applying the adhesive and installing the seal.
3. Perform welding and steel cutting work in accordance with Section 615.
4. Follow the manufacturer's recommendations for surface preparation, adhesive application, and compression seal installation. Place the compression seal at least 1/2-inch below the adjacent riding surface.

G. Silicone coated foam joint seal.

1. Prior to ordering the joint material, measure the joint opening to confirm the required size. If the required size conflicts with the contract, notify the engineer immediately.
2. Fully remove and dispose of the existing seal, gland, and adhesive.
3. Prepare the surface of the concrete/steel substrates in accordance with the manufacturer’s recommendations prior to installing joint materials.
4. Install joint material and use bonding agent in accordance with manufacturer’s recommendation.

624.4 Method of Measurement.

The Department will measure the quantity of joints as the number of linear feet of joints fabricated, installed, and accepted.

624.5 Basis of Payment.

A. Price and payment for:

1. A prefabricated expansion joint system constituting full compensation for removing and disposing of the existing joint system and fabricating, providing, and installing the expansion joint system.
2. Strip seal constituting full compensation for removing and disposing of the existing seal, cleaning existing extrusions, providing, and installing the strip seal.
3. Asphaltic plug joints constituting full compensation for pre-measuring, providing and placing all materials, cleaning and preparing the joint, and sealing the parapet joints.

4. Silicone seal constituting full compensation for removing and disposing of the existing seal, providing and placing all materials, and cleaning and preparing the joint.
5. Compression seal constituting full compensation for removing and disposing of the existing seal, providing and placing all materials, cleaning and preparing the joint, repairing spalls, and sealing cracks.
6. Silicone coated foam joint seal constituting full compensation for removing and disposing of existing seal, pre-measuring, providing and placing all materials, and cleaning and preparing the joint.

B. The Department will pay for concrete removal and repair in accordance with Section 628.

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
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
624017	SILICONE COATED JOINT SEAL, 1"	LF
624018	SILICONE COATED JOINT SEAL, 2"	LF
624019	SILICONE COATED JOINT SEAL, 3"	LF
624020	SILICONE COATED JOINT SEAL, 4"	LF
624021	CLOSED-CELL JOINT SEAL, 1"	LF
624022	CLOSED-CELL JOINT SEAL, 2"	LF
624023	CLOSED-CELL JOINT SEAL, 3"	LF

SECTION 625 — CONCRETE OVERLAYS

625.1 Description.

This work consists of providing materials and constructing a concrete overlay on concrete deck surfaces.

625.2 Materials.

A.	Latex-Modified Concrete (LMC)	Section 1046.1
B.	Polyester Polymer Concrete (PPC)	Section 1046.2
C.	Modified Class D Portland Cement Concrete (MCD)	Section 1046.3

625.3 Construction.

625.3.1 Pre-Construction.
Schedule a pre-construction meeting 14 calendar days in advance of starting construction for all overlay types.

625.3.2 Submittals.
Provide required submittals for the applicable overlay system 14-days prior to the pre-construction meeting.

A. All Overlay systems

Submit a Construction plan that includes:

1. Surface Preparation procedures:
   a. Milling and disposal of existing overlay(s).
   b. Testing procedures to identify unsound concrete.
   c. Removal and disposal method of unsound concrete and incidental waste.
   d. Repair method for areas of unsound concrete.
   e. Substrate scarification technique and procedure.
   f. Cleaning of concrete substrate and maintenance of cleaned surface prior to overlay application.
2. Concrete design and mixing procedures.
3. Overlay placement:
   a. Joint locations and plan to ensure longitudinal joints are located along centerline or edge of travel lanes.
   b. Sequence of placement.
   c. Placement widths.
   d. Planned placement lengths.
   e. Placement direction.
4. Equipment Descriptions for:

a. Performing surface preparation.

b. Measurement, Mixing, Placement, finishing, curing, and texturing overlay.

5. Method for isolation of expansion joints, inlets, manholes, scuppers, and other metal obstructions.
6. Method for measuring and maintaining the overlay thickness.
7. Concrete curing procedures.
8. Provision of lighting for night work.
9. Protection plan for traffic and adjacent structures from construction activities.
10. Procedures for disposal of excess material and material containers.
11. Procedure for cleanup of all necessary equipment and disposal of cleanup waste.
12. Procedure for cleanup of material spills.
13. Experience and Personnel Qualifications.

a. Documentation that a representative from the latex modified or polyester polymer system manufacturer will be present during overlay operations. The representative must have experience with installation of the specified system on projects of similar size and scope. Submit the manufacturer representative qualifications.

b. Or documentation as follows.

i. Documentation that the contractor has successfully completed a minimum of 3 overlay projects using the specified material within the last 5-years. Documentation must include a description of each project, location, owner/agency name and contact information, construction date, and overlay quantity.

ii. Documentation that assigned supervisory personnel have experience managing projects using the specified material. Experience must be on a minimum of 3 overlay projects using the specified material. Documentation must include a description of each project, location, owner/agency name and contact information, construction date, and overlay quantity.

iii. A manufacturer's letter of certification that the contractor is an approved installer.

iv. Documentation that approved qualifying personnel will oversee all operations.

14. Equipment descriptions for application of PPC primer coat or MCD bonding agent.

B. PPC Additional Submittals.

1. Manufacturer recommended installation instructions.
2. Materials information as required herein.
3. MSDSs for each material.
4. Independent test results within 1 year of start of overlay installation that demonstrate specification conformance.
5. Certification that PPC mixing equipment meets calibration per Caltrans California Test CT 109 or approved equal. Certification must be within 1-year of project operations.

625.3.3 Latex-modified Concrete.

A. Surface preparation.

1. Milling.
   a. For existing concrete decks and approach slabs, mill off the depth of concrete or hot mix specified in the contract.
   b. For existing concrete decks and approach slabs with existing concrete overlays, mill off the existing overlay.
2. On bridge decks or approach slabs with a hot mix overlay, and no additional concrete milling is specified, scarify the exposed concrete surface an additional 1/8-inch to 1/4-inch deep to create a bond for the proposed overlay.
3. After the initial removal, inspect the deck and outline areas of unsound concrete for removal, subject to the engineer's approval. Repair areas of unsound concrete in accordance with Section 628 and as specified in the Plans.
4. Saw straight and vertical edges to transverse and longitudinal joints of previously placed overlays before placing overlay against these surfaces.
5. Shot-blast or grit-blast the areas to receive the overlay no more than 24 hours before beginning placement. Hydro demolition may be used when approved by the engineer. Blast-clean the vertical edge of any previously placed lanes of overlay to promote bond. If it is necessary to remove materials detrimental to achieving bond, clean with detergent followed by shot or grit-blasting and air-blast-clean.
6. Immediately before concrete placement, wet the clean surface with water to a saturated surface dry (SSD) condition. Saturated surface dry (SSD) is a state where the concrete has absorbed as much water it can possibly absorb without ponding or puddles forming on the surface. Achieve SSD condition by placing wet burlap on the surface for a minimum of 24-hours or by other means submitted for approval by the engineer. Use compressed air, free of oil, to blow out any standing water in areas of concrete removal.
7. Prevent contamination of the cleaned and wetted deck by placing a minimum 4 mil thick polyethylene film or other material approved by the engineer that completely covers the deck surface prepared for overlay.

B. Mixing Equipment and Materials

1. Use approved proportioning and mixing equipment that is self-contained, mobile, and the continuous mixing-type. Provide mixers that are:
   a. Self-propelled and capable of carrying enough unmixed dry, bulk cement, sand, coarse aggregate, latex modifier, and water to produce no less than 6-cubic yards of latex modified PCC on the site;
   b. Capable of measurement of cement introduced into the mix by a visible recording meter equipped with a ticket print-out to indicate the quantity;
   c. Provides control of the flow of water and latex emulsion into the mixing chamber and has a flow meter that is adjustable for minor variations in the moisture of the sand and aggregate;
      i. Calibrated to automatically proportion and blend all components of indicated composition on a continuous or intermittent basis, as required by the finishing operation, and discharges

mixed material through a conventional chute directly in front of the finishing machine. Calibration must be performed by an approved testing laboratory or by the Department with evidence of accuracy being a yield that is within a tolerance of 1.0 percent according to the following test:

With the cement meter set on zero and all controls set for the desired mix, activate the mixer and discharge mixed material into a 0.25 cubic yard container 3 feet square by 9 inches deep. When the container is full the cement meter should show a discharge of 1.875 bags of cement.

d. Provide a mixer with enough capacity that allows placement and finishing operations to proceed at a steady pace.

2. Mix the overlay concrete in an approved, clean mixer at the site. Add the proportioned ingredients to the mixer in accordance with the recommendations of the manufacturer of the latex modifier.

   a. Do not place bags identified by the manufacturer as dissolving or breaking up during mixing or any other containers holding ingredients into the mix.

   b. Meet the slump range of 4 to 6-inches at the point of discharge.

   c. Follow the latex manufacturer's minimum mixing time recommendations to secure the correct air content and slump.

   d. Ensure that the overlay concrete remains uniform in composition and consistency when discharged from the mixer.

   e. The maximum time allowed between the start of mixing to the completion of discharge of the overlay concrete at the worksite is 60-minutes.

C. Placement

1. When placing 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. Ensure the temperature at the point of discharge does not exceed 85 degrees F.

2. Place the latex overlay concrete only when certain the ambient temperature will remain above 45 degrees F for the entire curing period.

3. Do not place an overlay adjacent to a previous overlay that has cured for less than 3 cure-days in accordance with Section 625.3.3.E. If ambient temperature falls below 45 degrees F during a cure day, the time below 45 degrees F will not be included in the 24-hour period.

4. Immediately before placing the overlay, cover the concrete surfaces with a coating of bonding grout consisting of the overlay material brushed onto the deck. Scrub the grout onto saturated surface-dry deck areas. Do not allow excess grout to collect in low areas. Apply the bonding grout for only a short distance in advance of the placement of the overlay. The engineer will require reapplication of the grout if the grout dries before overlay placement.

5. Place overlay concrete in accordance with Section 610.3.4 with a lift thickness in accordance with the contract and a maximum overlay thickness lift of 2 1/2-inches.

6. The maximum allowable time between the discharge and the final finishing of the overlay concrete is 10-minutes.

7. In case of a delay in the placement operation:
   a. Protect the end of the placement from drying during delays of 1-hour or less with several layers of wet burlap.
   b. For delays exceeding 1-hour, install a construction dam or bulkhead;
   c. When the delay exceeds 90-minutes, discontinue further placement. To continue pouring, provide a gap, between the ceased operation and the continuation, long enough for the finishing machine to clear the previously placed overlay concrete.

D. Consolidating and finishing.

1. Consolidate and finish, in accordance with Section 610.3.4. Use spud vibration in deep pockets, edges, and adjacent to joint bulkheads. Provide a sufficient number of spud vibrators to simultaneously vibrate each edge of the pour behind the finishing machine. Hand-finish with a float along the edge of the pour or on small areas of repair. Perform edge-tooling at joints, except next to metal expansion dams, curbs, and previously placed lanes.
2. Use an approved finishing machine that complies with Section 610.3.4.D.4 and has a vibrating pan to properly consolidate the mix.
3. 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 takes place. Immediately correct irregularities exceeding 1/4-inch in 10-feet. Test the overlay concrete surface for smoothness, in accordance with Section 610.
4. Complete final finishing operations before a plastic film forms on the surface.

E. Curing.

1. within 1-hour after finishing, cover the finished overlay surface with a layer of wet burlap and with a minimum 4-mil thick white, opaque polyethylene film. Lap sheeting a minimum of 6-inches. For a period of 2 cure-days keep the burlap wet by the continuous application of water using soaker hoses. After the 2-day wet cure period, remove the polyethylene and burlap and air cure for 3 cure-days. Record time, ambient temperature, and surface temperature throughout the curing period. Prohibit traffic on the overlay during this time.
2. Maintain the temperature at the overlay surface above 45 degrees F until completion of the curing period.
3. Improper curing of the overlay may result in rejection of the overlay.

F. Seal all joints including the perimeter of patches with a Low Viscosity High Molecular Weight Methacrylate Sealer that conforms to Section 1045.4. Seal or repair cracking in a manner approved by the engineer before opening to traffic. The Department will sound the deck and the Contractor will remove and replace delaminated areas in accordance with Section 628. Correct areas of ponding to provide drainage away from the bridge deck. Crack repairs, removal and replacement of delaminated areas and correction of ponding will be performed by the contractor at no additional expense to the Department.

G. Groove the surface in accordance with Section 610.

625.3.4 Polyester Polymer Concrete.

A. Material.

1. Shipping and Storing.
   a. Ship material in containers, bearing the manufacturer's label specifying the date of manufacture, batch number, brand name, quantity, and the date of expiration or the shelf life date. Ensure that the label of at least 1 of the system components has the mixing ratio printed on it. If using bulk resin, notify the engineer in writing 10-days before delivery of the bulk resin. The Department defines bulk resin as resin stored in containers larger than 55-gallons.
   b. Store materials in accordance with the manufacturer's recommendation to ensure its preservation until use. Ensure conformance with applicable fire codes that may require special storage facilities for some components of the overlay system.
2. Mix Composition.
   a. Use polyester polymer concrete containing approximately 12 percent polyester resin by weight of dry aggregate. Adjust the percentage during placement to enable proper finishing and texturing of the overlay surface.
   b. Use an amount of polyester concrete initiator that will produce an initial set time between 30 and 90-minutes. Use a Gillmore needle in accordance with the requirements of ASTM C266 to determine the initial set time. Use accelerators or inhibitors recommended by the resin supplier to achieve proper set times.

B. Surface Preparation.

1. During surface preparation and overlay application, take precautions to protect traffic from construction activities. Provide shielding as required or directed by the engineer.
2. Before applying primer, clean the concrete deck area to remove materials that may interfere with the bonding or curing of the overlay.
3. Use only equipment for surface preparation specified by the overlay manufacturer and approved by the engineer. Unless otherwise specified, use automatic, self-propelled shot blasting units to clean concrete surfaces. Use a vacuum to recover spent abrasives. Use steel shot as abrasives for blast cleaning. In areas not accessible to machinery, clean with manual blast cleaning equipment. Use magnetic rollers to remove spent shot remaining on the deck after vacuuming.
   a. Determine the size of shot, flow of shot, forward speed of shot blast machine, and the number of passes necessary to provide a surface capable of a tensile bond strength greater than or equal to 250 PSI in accordance with ASTM C1583.
4. Clean steel surfaces that will contact the overlay in accordance with SSPC-SP10, Near-White Commercial Blast Cleaning. The Department will not allow wet blasting methods for cleaning.
5. After completing the cleaning operation, ensure that there is no oil, grease, dirt, rust, loose particles, spent abrasives, or other foreign material on any of the surfaces planned for the overlay.
6. Do not place the overlay until the engineer inspects and approves the cleaned surface.
7. Do not expose cleaned pavement surfaces to vehicular or pedestrian traffic other than what is required for the overlay operation before overlay placement. If the pavement surface is contaminated before overlay placement, re-clean the area by abrasive blasting to engineer's satisfaction.

8. Provide coverings to protect adjacent exposed areas not planned for an overlay. Clean and repair damage resulting from the overlay application to the engineer's satisfaction.

C. Mixing.

1. Use continuous automated mixers that:

   a. Contains an auger screw/chute device capable of thoroughly mixing initiated binder resin with dry aggregate;

   b. Contains a plural component pumping system capable of handling polyester resin and initiator while maintaining proper ratios to achieve specified set / cure times. Initiated resin must flow through a static mix tube for a duration sufficient to completely mix the liquids;

   c. Is equipped with a visible readout gauge that automatically measures and records the following, a minimum of every 5-minutes: aggregate and resin volumes, time, and date. Submit to the engineer the recorded volumes at the end of each day;

   d. Produces a satisfactory mix consistently during the entire application process; and

   e. Is a portable mechanical mixer of appropriate design and size as recommended by the PPC System provider.

D. Placement.

1. Prime Coat.

   a. Before applying the prime coat, ensure that the underlying concrete is fully cured and the area is dry. Blow the area clean with oil-free compressed air. Apply the prime coat only when the surface temperature is between 50 degrees F and 100 degrees F.

   b. Apply the prime coat to completely cover the surface receiving the polyester concrete. Use the rate of spread recommended by the manufacturer. Allow the prime coat to cure a minimum of 15-minutes before placing polyester concrete.

2. PPC Overlay.

   a. Isolate expansion joints before overlaying or saw cut the joint within 4 hours after overlay placement. The engineer will determine the exact time of the saw cut.

   b. Place concrete within 15 and 120-minutes after applying the prime coat.

   c. Place the concrete only when the surface temperature is 50 degrees F or higher.

   d. Place concrete before gelling and within 15-minutes following the addition of initiator, whichever occurs first. Discard polyester concrete not placed within this time frame.

   e. Place the overlay at a minimum of 3/4-inch depth.

   f. Use a self-propelled slip-form paving machine modified or specifically built to place the PPC overlay in a manner that meets contract requirements. Phased construction or limited quantity, as approved by the engineer, may submit an alternate operation for approval prior to use. The paving machine must:

      i. Use a vibrating pan to consolidate and finish the PPC. The paver primary pan must measure not less than 2-feet in the dimension parallel to the direction of paver travel. This measurement does not include finishing attachments, bolt on sections, or trailing pan extensions.

ii. Use hydraulically controlled grade automation to establish the finished profile. The automation must be fitted with substrate grade averaging devices on both sides of the automation sensor of the sensor shall be constructed to work with string-line control. It is acceptable to match grade when placing lanes adjacent to previously placed accepted overlays.

iii. Has sufficient engine power and weight to provide adequate vibration of the finishing pan while maintaining consistent forward placement speed.

iv. Is capable of both forward and reverse under its own power.

v. Roller screeds will not be permitted.

E. Consolidating and Finishing.

1. Termination edges of the overlay may require finishing by hand trowel due to obstructions.
2. Use a ruler to check the overlay thickness before its initial set. If the engineer determines that the minimum thickness was not attained, add an additional layer with a minimum thickness of 1/4-inch after the overlay hardens.
3. Apply the finish sand by either mechanical means or hand broadcasting immediately after strike-off, before gelling occurs, and at a minimum rate of 2.75 ounces per square foot.
4. Ensure that the completed overlay surface is free of any smooth or glassy areas such as those resulting from insufficient quantities of surface aggregate. Repair surface defects in the manner recommended by the manufacturer and approved by the engineer.
5. Texture the surface in accordance with Section 610.3.4.

F. Curing.

1. Protect overlay from moisture for a minimum of 4-hours after finishing. Allow the overlay to reach final cure and a minimum of 4-hours after final finishing, before subjecting the overlay to traffic and equipment.

G. Surface Requirements.

1. Test the surface smoothness with a straight edge. Ensure that the surface does not vary more than 1/4-inch from the lower edge of a 10-foot long straight edge placed in any direction. Adjust surfaces that fail to conform to the tolerance by grinding with an approved grinding tool.
2. The engineer will check the overlay surface immediately after it has hardened to ensure that no depressions exist that will cause water ponding. Repair surface depressions in the manner recommended by the manufacturer and approved by the engineer.

625.3.5 Modified Class D Portland Cement Concrete.

A. Surface Preparation.

1. Prepare deck surface in accordance with Section 625.3.3.A.
2. Prior to placing the overlay, completely cover the concrete substrate surface with a concrete bonding agent. The horizontal surface shall receive a latex bonding agent that conforms to ASTM C1059 Type II. All vertical edges at all overlay joints shall receive an epoxy bonding agent that conforms to AASHTO M235 Type V. Follow the bonding agent manufacturer’s application recommendations

B. Mixing.

Mix PCC in accordance with Section 1022.

C. Placement.

1. Do not place an overlay adjacent to a previous overlay that has achieved less than 50 percent of design strength.
2. The temperature of all surfaces that come into contact with the mix shall be no less than 40 degrees F and no greater than 105 degrees F.
3. Place concrete a minimum of 1 1/2-inch thick.
4. Place overlay concrete in accordance with Section 610.3.4.B. In case of placement operation, delay comply with Section 625.4.1.C.5.
5. Consolidate and finish concrete in accordance with Section 625.3.2.D. Use an approved finishing machine that complies with Section 610.3.4.D.4

D. Curing.

1. Immediately following placement of the concrete keep the overlay surface moist by a water fog spray applied without damaging the surface.
2. Start curing immediately after the free water leaves the surface and finishing is completed.
   a. Cover the finished overlay surface with wet burlap in compliance with Section 1022.6.C. Keep the burlap wet throughout the curing period by using soaker hoses to apply water in compliance with Section 1021.
   b. Cover the wet burlap with a minimum 4-mil thick white opaque polyethylene sheeting in compliance with Section 1022.6.B. Use sheets of the widest practical width. Overlap sheets a minimum of 6 inches and seal with tape, mastic, glue or other approved method to form a waterproof cover over the entire overlay surface.
   c. Secure the polyethylene sheet material to prevent displacement by wind. Immediately repair sheets torn or damaged during the curing period. All curing operations must be performed without damaging the surface.
   d. Surface damage incurred during the curing process will be repaired by the contractor at no expense to the department.
3. Maintain the temperature at the overlay surface at 40 degrees F or greater for the entire curing period.
4. Cure for 14 cure-days.

E. Sealing Joints.

1. Seal all joints, including the perimeter of patches, with a Low Viscosity High Molecular Weight Methacrylate Sealer that conforms to Section 1045.4.

F. Surface Requirements.

1. Repairs.
   a. Correct areas of ponding to provide drainage away from the deck surface.

b. Areas determined to be delaminated by the Department sounding the deck will have to be removed and replaced at the Contractor's expense.

c. Crack repairs must be performed in accordance with Section 628.3.B.

2. Groove the surface in accordance with Section 610.3.4.i when the overlay concrete has reached design strength.

3. Apply Silane Sealer that complies with Section 1045.3 to the grooved surface as specified in Section 613.3.D.

625.4 Method of Measurement.

A. The Department will measure:

1. Concrete overlay material by the cubic yard.

2. Concrete overlay installation by the square yard – inch.

625.5 Basis of Payment.

A. The Department will pay for providing overlay material at the contract unit price per cubic yard. Price and payment will constitute full compensation for the material and delivery to project site.

B. The Department will pay for placing overlay material at the contract unit price per square yard-inch. Price and payment will constitute full compensation for:

1. Surface preparation;

2. placing the bonding grout or primer coat;

3. placing, consolidating, curing and grooving the concrete overlay; and

4. constructing and removing test patches.

C. The Department will pay for:

1. Removal and repair work below the initial milling in accordance with Section 628;

2. milling of concrete or hot mix in accordance with Section 760;

3. providing and placing silane sealer in accordance with Section 613; and

4. providing and placing the methacrylate sealer in accordance with Section 613.

D. The Department will make no additional payment for repair work as directed by the engineer.

ITEM	DESCRIPTION	UNIT
625000	PROVIDING POLYESTER POLYMER CONCRETE OVERLAY	CY
625001	PROVIDING LATEX-MODIFIED CONCRETE OVERLAY	CY
625004	PROVIDING MODIFIED CLASS D PCC OVERLAY	CY
625010	LATEX-MODIFIED CONCRETE OVERLAY PLACEMENT	SY-IN
625011	POLYESTER POLYMER CONCRETE OVERLAY PLACEMENT	SY-IN
625012	MODIFIED CLASS D PCC OVERLAY PLACEMENT	SY-IN

SECTION 626 — METAL RAILINGS

626.1 Description.

This work consists of fabricating, providing, and installing metal railings.

626.2 Materials.

A.	Elastomeric Pads	Section 623
B.	Steel	Section 1039
C.	Anchor bolts	Section 1039
D.	Aluminum	Section 1044

626.3 Construction.

A. Submittals

1. Prepare and submit working drawings for the metal railings in accordance with Section 105. Show all details of the railings and of the materials proposed for use. Obtain the engineer's approval before fabrication.

B. Fabrication

1. Fabricate formed sections of steel rail from mild steel.
2. The Department will allow use of standard steel pipe for pipe sections.
3. Grind or fill exposed welds to provide a smooth surface.
4. Weld aluminum materials using an inert gas-shielded, electric, arc-welding process using no welding flux in accordance with AWS D1.2 Structural Welding Code - Aluminum.
5. Cut aluminum by means other than torch or flame cutting. Grind smooth rough or sharp corners.
6. After fabrication, galvanize anchor bolts, nuts, and all steel portions of rails. Leave aluminum portions ungalvanized. Repair minor abrasions in galvanized surfaces with zinc-rich paint.

C. Packaging, Handling, and Storage.

1. Handle, pack, ship, and store the materials in a manner that will protect the finish from damage.
2. Store railing and incidental parts on blocking, racks, or platforms preventing contact with ground. Protect the railing and incidental parts from corrosion or damage. Keep the materials free from dirt, oil, grease, and other foreign material. Repair or replace damaged material, as directed by the engineer.

D. Installation.

1. Set anchor bolts and hold in place with a template before pouring concrete. Apply a protective coating of grease or oil to the parts of anchor bolts exposed above the finished concrete before pouring.

2. Set each post base on a preformed elastomeric pad. Conform the outline of the pad to the base of the post or base plate. Set posts plumb and set rails parallel to grade, unless otherwise noted in the contract.
3. Place rails after releasing the span falsework. Adjust metal rails before anchoring to ensure proper matching at abutting joints, correct alignment, and camber throughout the length. Drill holes for field connections with the rails in place.
4. In areas where aluminum alloys come in contact with other metals or concrete, coat with a dielectric aluminum-impregnated caulking compound, or place a synthetic rubber gasket between the 2 surfaces.
5. Grind smooth rough or sharp corners. Burr anchor bolts and other connecting bolts and fasteners to prevent loosening after completing erection.
6. Repair areas of damaged coating with the same coating material in accordance with the manufacturer's recommendation. Before requesting acceptance of the installation, clean the railing. Use cleaning methods and agents in accordance with the recommendations of the rail manufacturer.

626.4 Method of Measurement.

A. The Department will measure metal railings as the number of linear feet fabricated, placed, and accepted.

626.5 Basis of Payment.

A. The Department will pay for accepted quantities at the contract unit price per linear foot. Price and payment will constitute full compensation for providing, fabricating, and installing all materials, and for repair of any damage due to construction.

ITEM	DESCRIPTION	UNIT
626000	STEEL PEDESTRIAN RAILING	LF
626001	STEEL RAILING, TYPE 1	LF
626002	STEEL RAILING, TYPE 2	LF
626010	ALUMINUM PEDESTRIAN RAILING	LF
626011	ALUMINUM RAILING, TYPE 1	LF
626012	ALUMINUM RAILING, TYPE 2	LF

SECTION 628 — CONCRETE REPAIR AND REHABILITATION

628.1 Description.

This work consists of repairing or rehabilitating concrete structures.

628.2 Materials.

A.	Portland Cement Concrete (PCC)	Section 1022 and Section 1023
B.	Reinforcement and Splice Couplers	Section 1037
C.	High Molecular Weight Methacrylate Crack Sealer	Section 1045
D.	Non-Shrink Grout	Section 1047.2
E.	Epoxy Grout	Section 1047.4
F.	Epoxy Injection System	ACI 503.7-07
G.	Epoxy Bonding Agent	ASTM C881
H.	Low or Medium Modulus, Neutral-curing, Silicone Crack Sealant	ASTM D5893
I.	Polyurethane Crack Sealant	ASTM C920
J.	Mortar Sand	Section 1003
K.	Tap-Con Screws	Engineer Approval

628.3 Construction.

628.3.1 Submittals.

A. Submit the contractor qualifications for each of the respective repair and rehabilitation operations verifying successful completion of at least 3 separate repair or rehabilitation projects within the last 5-years using the proposed manufactured products. The engineer may accept a manufacturer's letter of certification for an approved installer. Ensure that qualifying personnel oversee repair and rehabilitation operations.

B. Submit details of the methods and materials needed to attain sufficient early strength that will allow opening the roadway to traffic in a timely manner when contract time constraints do not allow the cure times specified in Section 610.

C. Submit equipment used in all aspects of concrete repair and rehabilitation operations.

D. Submit formal meeting minutes from a pre-construction meeting held 14 calendar days before the start of work to brief the personnel performing the work and the engineer on the operations. Submit a concrete repair work plan to document the proposed repair means and methods discussed during the preconstruction meeting.

628.3.2 Crack Repairs.

A. Structural Repair.

1. Limitations.

a. Crack widths of 0.002-inch to 0.25-inch.

b. Any surface orientation, including inverted surfaces.

2. Repair Method: Use epoxy injection in accordance with the following:

a. Personnel requirements.

i. Individual performing epoxy injection repairs must be trained by the epoxy injection system manufacturer to install and operate pressure injection equipment or

ii. the epoxy injection repairs must be overseen in person by the epoxy injection system manufacturer's technical representative.

b. Perform epoxy injection according to the process listed below or manufacturer recommendations. If the methods conflict between these specifications follow the manufacturer recommendations.

i. Install injection ports or tees spaced 6-inches to 12-inches apart for vertical repairs and 6 inches to 18-inches apart for horizontal repairs.

ii. Do not set ports or tees closer together than the thickness of the concrete member if full-depth penetration is required.

iii. Select the depth and spacing of holes for the ports or tees to ensure no further damage occurs to the member under repair and that is appropriate to the flow characteristics and injection pressure of the epoxy for crack widths and depths present.

iv. Set ports or tees in dust-free holes made with vacuum drills or chipping hammers.

v. After anchoring the ports or tees in the hole with epoxy binder, seal the crack surface with epoxy binder between the ports or tees to ensure retention of the pressure injected epoxy within the confines of the member.

vi. Apply epoxy binder to clean dry surfaces and substrate at temperatures no less than 50 degrees F.

vii. After the injected epoxy has hardened, grind ports or tees flush with the concrete surface. Finish the repaired area to match the existing concrete surface.

B. Sealing Repair:

1. Repair Methods and Limitations.

Sealing repair method and material required to use the following table to determine sealing repair and material:

Table 628.3-1. Sealing Repair Methods and Material Requirements.

Material	Crack Surface Orientation	Crack Width	Structure Type	Application Method
Low Viscosity Epoxy or High Molecular Weight Methacrylate	Horizontal Maximum 8% slope	0.002" – 0.25"	All	Poured Gravity Fed
Polyurethane or Silicone	Horizontal Sloped Vertical	0.125" – 1"	All	Gun or Trowel

	Inverted			
Non-Shrink Grout	Horizontal Sloped Vertical	≥ 1”	All	Trowel

2. Low Viscosity Epoxy or High Molecular Weight Methacrylate
   a. Remove surface contaminants by blowing out the crack with oil-free compressed air.
   b. Prepare the surface and damming material per manufacturer recommendation. Take measures to prevent sealing material leakage when a crack has propagated to a non-horizontal surface.
   c. Perform repairs when surface and ambient temperatures are within the manufacturer recommended ranges.
   d. Mix material components in accordance with the manufacturer’s recommendations.
   e. Apply sealing material in accordance with the manufacturer’s recommendations.
   f. Cover surface areas where excessive sealing material remains with a light broadcast of dry mortar sand that complies with Section 1003 at the time recommended by the manufacturer. Use a quantity of sand necessary to absorb the excess sealing material.
   g. Following all manufacturer curing methods and recommendations prior to opening to traffic.
3. Polyurethane or Silicone
   a. Seal cracks in horizontal surfaces with self-leveling sealant. Seal all other surfaces with non-sag sealer.
   b. Rout cracks by grinding to create a V-shaped groove with the crack centered in the groove. Routed grooves must be a maximum 1/2-inch depth.
   c. Remove contaminants by blowing out crack with oil-free compressed air.
   d. Ensure the ambient and surface temperatures are within the manufacturer’s recommended placement range before applying the sealant.
   e. If required, apply primer as recommended by the manufacturer.
   f. Apply sealant in accordance with manufacturer's recommendations to form a smooth surface.
   g. Cure sealant in accordance with the manufacturer’s recommendations. Curing must be completed prior to opening to traffic.
4. Non-Shrink Grout.
   a. Tool the crack to create a dovetail slot that is a minimum 1-inch depth with a base and at least 1/4-inch greater than the crack width
   b. Remove contaminants from the tooled crack by blowing the crack out with the oil-free compressed air or by pressure washing.
   c. Ensure that the ambient and surface temperatures conform to the manufacturer’s recommendation during grout mixing, placement, and curing.

d. Non-shrink grouts that do not contain a pre-mixed bonding agent require application of an epoxy bonding agent the conforms to AASHTO M235 Type V or latex bonding agent that conforms to ASTM C1059 Type II to all surfaces that are in contact with the repair grout. The epoxy bonding agent must comply with Section 628.3.4.C and be applied in accordance with the manufacturer's recommendations.

e. Mix non-shrink grout in accordance with the manufacturer's recommendation to a dry-pack consistency.

f. Apply non-shrink grout by troweling the material into the tooled crack in approximately 1/2-inch lifts. Tamp each lift with a wood or steel tool that will fit into the crack. Trowel the final lift flush with the concrete surface. Cracks in sloped or vertical surfaces require form placement after troweling to prevent material sagging.

g. Cure in accordance with manufacturer recommendations.

628.3.3 Non-Shrink Grout Repair.

A. Repair non-shrink grout used to fill shear keys between precast concrete elements, or various pockets and voids associated with precast concrete elements, as follows:

1. Remove deteriorated grout in accordance with Section 628.3.4. taking care not to damage the adjacent precast concrete elements. If damage occurs, repair concrete in accordance with Section 628.3.4.
2. Clean the concrete surface by blowing off dust and debris with oil-free compressed air.
3. Wet the concrete surfaces before placing grout. Do not allow standing water to remain in the area receiving grout.
4. During grout placement, prevent falling material from reaching the roadway, waterway, or railroad area below.
5. Prepare, place, and cure in accordance with the manufacturer's recommendations.

628.3.4 Spall and Delamination Repair.

A. Limitations.

1. This section does not apply to prestressed elements or bridge decks

B. Definitions:

1. Shallow spalls are spalls that do not extend below the top mat of reinforcement.
2. Deep spalls are spalls that extend below the top mat of reinforcement.
3. PCC masonry rehabilitations are deep-spall patches that exceed the 0.5 cubic yard threshold in a single area.

C. Materials.

1. PCC for shallow spall repairs shall comply with Section 1023.
2. PCC for deep spall repairs shall comply with Section 1022. Use Class A concrete in compliance with Table 1022.9-1.
3. Epoxy bonding agents shall conform to AASHTO M235 Type V.
   a. Use Grade 2 epoxy on horizontal level surfaces.

b. Use Grade 3 epoxy on vertical or angled surfaces.

c. Use Class B epoxy when substrate surface temperature is 40 to 60 degrees F.

d. Use Class C epoxy when the substrate surface temperature is above 60 degrees F.

e. A bonding agent conforming to ASTM C1059 Type II may be used when approved by the engineer.

D. Repair Methods.

1. Repair to the depth noted in the contract. The dimension may change in field if the engineer deems it necessary. If, due to field conditions, removal of deteriorated concrete includes a bearing seat not specified in the contract or any area meeting the threshold for rehabilitation of PCC masonry not specified in the contract, notify the engineer immediately. Obtain the engineer's approval before resuming work in these areas.

2. When destruction of the bond between existing concrete and reinforcing steel occurs, remove the concrete adjacent to the bar to a depth that will allow the repair concrete to bond to the entire surface of the exposed bar. Modify the repair area limits to meet the reinforcement lap splice or mechanical coupler requirements.

3. Saw cut the edges of the repair area

a. Perpendicular to the concrete face at least 1-inch deep, without damaging reinforcing bars.

b. A minimum of 6-inches beyond the visibly spalled, disintegrated, delaminated, deteriorated, loose, or honeycombed concrete.

4. Remove spalled, disintegrated, delaminated, deteriorated, loose, honeycombed, and unsound concrete. Collect debris and prevent material from falling on the roadway, waterway, or railroad area below. Remove material from the site and dispose of in accordance with Section 106.8. Remove slurry produced by concrete wet sawing that enters prepared areas before placing the patch.

a. For shallow spalls, remove concrete above the top of the reinforcement bar. Use a 15-pound pneumatic hammer unless otherwise noted in the contract. The engineer may approve use of alternative tools. Do not remove concrete below top of reinforcement bar unless approved by the engineer.

b. For deep spalls and rehabilitation of PCC masonry, remove concrete a minimum of 1 inch behind the existing reinforcement without damaging the reinforcement. Use a 15-pound pneumatic hammer for work on a superstructure or a 30-pound pneumatic hammer for work on a substructure, unless otherwise noted in the contract. The engineer may allow use of alternative tools. Limit removal at any 1 location as noted in the contract and as the engineer deems necessary due to field conditions.

5. For deep spall and PCC masonry rehabilitation, repair existing bar reinforcement as follows:

a. Replace, splice, or supplement the existing bar reinforcement when an existing bar has a loss of 20 percent or more of the original cross section, is broken, or is damaged during the repair. The engineer will decide which bars need repairs and how to make the repairs as follows:

b. Replace with a new bar of the same type and equal or greater cross-sectional area as the existing bar.

i. Replace the entire length of the existing bar where possible.

ii. Replace the damaged length by cutting the existing bar and using a mechanical coupler to splice the new bar to the existing bar.

iii. Supplement an existing bar by installing a new bar as a lap splice. Extend the bar 30 bar diameters in each direction from where the section loss or breaks ends. Remove the damaged portion of the existing bar.

c. Clean to bright metal for black bars only or to visible epoxy coating for epoxy-coated bars by removing rust, coatings, or other material using grit-blast, wire-brushing, or other approved means. Apply a 2-part epoxy coating by brush to areas of the existing epoxy-coated reinforcing steel that exhibit flaked or scratched surfaces at a thickness of 10-mils or greater. Do not epoxy-coat the concrete surface beyond the bars. Do not epoxy coat existing black bar.

d. Clean and prepare the concrete surface area in accordance with the bonding agent manufacturer's recommendations.

6. For shallow spall repairs, install tap-con screws as recommended by the manufacturer to the cleaned concrete surface. Place the screws at 6-inches center to center each way with a minimum 1/2-inch clear cover, with at least 2 screws installed in a shallow spall repair. Apply the bonding agent as recommended by the manufacturer. 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.

7. For deep spalls and PCC masonry rehabilitation, apply the bonding agent as recommended by the manufacturer and place concrete in accordance with Section 610. When necessary, provide formwork in accordance with Section 604.

8. For deep spalls, substitute patching material conforming to Section 1023 for the Class A mix design, upon the engineer's approval, except for bridge seat areas. Use Class A concrete, or approved equal, for spall depths greater than 6-inches.

9. For PCC masonry rehabilitation, use Class A concrete or an approved equal.

10. Form expansion or contraction joints in the concrete repair material at existing joint locations.

11. Finish the repaired area to match the existing concrete surfaces and architectural details.

E. Cure premixed packaged materials in accordance with manufacturers recommendations. Cure ready mix PCC materials in accordance with Section 610.3.6.B.1.b.

628.3.5 Concrete Riding Surface and Milled Surface Deck Repair.

A. Repair decks of a concrete riding surface or of a milled concrete surface that will receive an overlay as follows:

1. Provide shielding to protect traffic in accordance with Section 604.

2. The engineer will inspect the entire deck surface, or milled areas of exposed deck surface, to indicate the type and extent of repairs, if any.

3. Saw cut in accordance with Section 628.3.4.D.3 except that the minimum depth of a vertical face is 1/2-inch.

4. Remove deteriorated deck areas down to sound concrete, in accordance with Section 628.3.4.D.4. Do not operate mechanical chipping tools at an angle in excess of 45 degrees measured from the surface of the deck. For spalls on riding surfaces, chip down the perimeter of

the patch to make a 1/2-inch minimum depth vertical face from the top of the adjacent riding surface.

5. When the removal depth 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, provide and erect temporary protective shielding under the deck to prevent falling material from reaching the roadway, waterway, or railroad area below.
6. Refer to Section 628.3.4.D.5 for further guidance on cleaning, repairing, or replacing existing reinforcement.
7. After completely removing deteriorated concrete, clean the concrete surface in accordance with Section 628.3.4.
8. Patch spalled concrete, voids, and other defects as follows:
   a. The Department will not require any special treatment for cavities less than 1/2-inch deep on milled surfaces. Fill with the concrete overlay material.
   b. For cavities 1 1/2-inches or less deep on riding surfaces, fill the space with epoxy grout.
   c. For cavities 1 1/2-inches or more in depth, fill with Class D concrete.
   d. When the deck will receive an overlay, shot or grit-blast the patch surfaces repaired to assure proper bonding with the overlay. For riding surface repairs using Class D concrete, apply a broom or hand-tine finish. For riding surface repairs using epoxy grout, cover the area with a light broadcast of dry mortar sand meeting the requirements of Section 1003 before the epoxy grout hardens.

B. Cure premixed packaged materials in accordance with manufacturers recommendations. Cure ready mix PCC materials in accordance with Section 610.3.6.B.1.b.

628.3.6. Drilling holes and placing dowels.

A. Drill holes at the locations and to the minimum depth shown in the contract. Drill hole diameters in accordance with the epoxy grout manufacturer's recommendations for the dowel sizes, or as shown in the contract. Grout the anchor bolts or dowels in place using the epoxy grout in accordance with manufacturer's recommendations. Repair damage caused by the drilling operations to the engineer’s satisfaction.

628.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Epoxy injection as the number of linear feet of cracks injected and accepted.
2. Grouting and sealing cracks as the number of linear feet of cracks routed, sealed, and accepted.
3. Grout as the number of cubic feet of grout placed and accepted;
4. Shallow and deep spall repair as the number of cubic feet repaired, placed and accepted.
5. Rehabilitation of existing PCC as the number of cubic yards of concrete removed and repaired.
6. Concrete deck repair as the number of square feet of repairs made at the various depths, complete in place and accepted.
7. Drilling holes and installing dowels as the number of each hole drilled, grouted, and accepted.

B. The Department will measure dowels and anchor bolts under separate items.

628.5 Basis of Payment.

A. The Department will pay for accepted quantities at the contract unit price.

B. Price and payment for epoxy injection constitute full compensation for providing all materials, surface preparation, application, cleaning the areas of spills and other contaminates, and abrading the concrete surface areas.

C. Price and payment for routing and sealing cracks constitute full compensation for providing and placing all materials, crack routing, and surplus material removal.

D. Price and payment for repair of existing grout constitute full compensation for providing and placing all materials, removal and disposal of deteriorated grout, and surface preparation.

E. Price and payment for spall repair, PCC masonry rehabilitation, and concrete deck repair constitute full compensation for:

1. Providing and placing all materials;
2. Providing and erecting temporary protective structure;
3. reinforcement bar cleaning;
4. existing reinforcement bars splicing or replacement;
5. deteriorated concrete removal and disposal; and
6. surface preparation.

F. Price and payment for drilling holes and installing dowels constitute full compensation for providing and placing all materials.

G. The Department will pay for:

1. Concrete overlays under Section 625;
2. concrete sealing with methacrylate under Section 613;
3. concrete or hot mix milling under Section 760; and
4. dowels and anchor bolts under separate items

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
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

DIVISION 700 — MISCELLANEOUS CONSTRUCTION

SECTION 701 — PCC CURB, INTEGRAL PCC CURB, PCC MONOLITHIC MEDIAN, AND CURB OPENINGS

701.1 Description.

This work consists of constructing PCC curbing.

701.2 Materials.

A.	PCC, Class B	Section 1022
B.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7
C.	1/2-Inch Preformed Expansion Joint Material	Section 1042.2.A
D.	Bituminous Joint Sealant	Section 1042.2.B

701.3 Construction.

A. Provide a concrete flatwork technician with an ACI or NRMCA certification, or a certification from another Department approved certification program, to supervise concrete finishing. Provide the certification to the engineer before placing concrete.

B. Place concrete in accordance with Section 501.3, including the weather limitations in Section 501.3.8.

C. Foundation Preparation.

1. Excavate in accordance with Section 202.3 to the width, depths, and grades shown in the contract.
2. Remove unsuitable material when encountered and replace with approved material.
3. Compact the foundation.
4. When rock is encountered, excavate 6 inches below the bottom of curb and backfill with GABC.
5. Place GABC to the required thickness in accordance with Section 301.

D. Slip-forming.

Use molds of required height, width, and shape.

E. Fixed Forms.

1. Use clean wood or metal, extending the full depth of the concrete.
   a. Use straight and warp free forms, with a deflection no greater than 1/8-inch in 10-feet.
   b. Use forms rigid enough to resist the pressure of plastic concrete, with a deflection no greater than 1/8-inch in 10-feet.
2. The contractor may use composite material for radius work.

F. Curb Removal and Replacement.

1. Saw cut curb in accordance with Section 762.3. Cut the pavement a minimum of 18-inches from the face of the curb.
2. Remove bituminous concrete pavement, or PCC pavement, and dispose of in accordance with Section 202.
3. Remove existing curb in accordance with Section 211.3.
4. Construct new curb in accordance with this specification.
5. Perform bituminous patching in accordance with Section 401, or PCC patching in accordance with Section 503 or as otherwise specified by the contract.

G. Placing Concrete.

1. Place concrete in accordance with Section 501.3.
2. Transition the ends of curbs, approaches, exit ends of median islands, and triangular channelization island curb, in accordance with the Standard Construction Details.
3. Place Type IV polyurethane-bonded recycled rubber expansion joints as follows:
   a. To the full curb depth;
   b. at a maximum of 150-foot intervals and aligned with adjacent joints;
   c. at the beginning and end of radii;
   d. on both sides of structures or obstructions; and
   e. when confined against rigid structures or pavement.
   f. longitudinally between the edge of PCC pavement and face of curb or curb and gutter when curb is immediately adjacent PCC pavement.

H. Finishing.

1. Finish concrete a minimum of 2-inches below finished grade.
2. Use a wood or magnesium float to rub the surface smooth.
3. Check the flow line of the gutter to ensure positive drainage. Correct deviations in the flow line greater than 1/8-inch in 10-feet.
4. Match vertical alignment with adjacent surfaces such as curbs and drainage inlets.
5. Correct irregularities in grade or alignment of the front and back edges of the curb greater than 1/4-inch in 10-feet.
6. Round front and back edges in accordance with the Standard Construction Details.
7. Brush longitudinally along the surface.

I. Curing.

Cure in accordance with Section 501.3 and with materials in accordance with Section 1022.6.

J. Joints.

1. Construct contraction joints in accordance with the Standard Construction Details at a maximum of 10-foot and a minimum of 4-foot intervals using a tool or by saw cutting to a 1/8-inch minimum width and to a depth of 1-inch minimum on all finished surfaces.

2. Align joints with the adjacent pavement joints.
3. Form or tool the face of curbing to allow sealing when the curb is placed adjacent to PCC pavement, as shown in the Standard Construction Details.
4. Place expansion material in accordance with Section 701.3.G.

K. Form Removal and Backfilling.

1. Remove forms when concrete has cured sufficiently.
2. Backfill in accordance with the contract.

L. Cracked or damaged curbs.

1. For curbs with one hairline crack that does not exhibit signs of displacement, sawcut and seal the crack as directed by the engineer.
2. For curbs with more than one crack or otherwise damaged curbs, remove and replace the full curb section between the joints.

M. Adhere to the requirements of Section 501.5.3 Low Strength Concrete Adjustments.

701.4 Method of Measurement.

A. The Department will measure PCC Curb and Integral PCC Curb as the number of linear feet measured along the linear face of acceptably placed and completed curb.

B. The Department will measure PCC Monolithic Median as the number of linear feet measured along the centerline of the median.

C. The Department will measure curb openings as the number of curb openings installed.

701.5 Basis of Payment.

A. The Department will pay the quantity of PCC Curb, Integral PCC Curb, and PCC Monolithic Median at the contract unit price per linear foot. The Department will pay the quantity of curb opening at the contract unit price for each. Price and payment will constitute full compensation for:

1. Excavating within the template of the item including the foundation;
2. removal and disposal of existing materials;
3. foundation preparation;
4. providing and placing materials;
5. compaction;
6. providing forms and forming;
7. supplying, placing, finishing, and curing PCC;
8. constructing joints;
9. expansion joint material;
10. sealing;
11. backfilling;
12. removing surplus materials; and

13. removing and replacing cracked or damaged curb.

B. The Department will pay the quantity of curb opening at the contract unit price per each. Price and payment will constitute full compensation for:

1. Excavating within the template of the item including the foundation;
2. removal and disposal of existing materials;
3. foundation preparation;
4. providing and placing materials;
5. compaction;
6. providing forms and forming;
7. supplying, placing, finishing, and curing PCC;
8. constructing joints;
9. expansion joint material;
10. sealing;
11. backfilling;
12. removing surplus materials; and
13. removing and replacing cracked or damaged curb.

C. The Department will pay for:

1. Excavation and embankment outside the template of the item in accordance with Section 202 at the direction of the engineer or as otherwise required by the contact.
2. Rock removal in accordance with Section 202;
3. undercut excavation in accordance with Section 202;
4. PCC removal in accordance with Section 211;
5. saw cutting in accordance with Section 762; and
6. GABC in accordance with Section 301.

ITEM	DESCRIPTION	UNIT
701010	PCC CURB, TYPE 1-2	LF
701011	PCC CURB, TYPE 1-4	LF
701012	PCC CURB, TYPE 1-6	LF
701013	PCC CURB, TYPE 1-8	LF
701014	PCC CURB, TYPE 2	LF
701015	I.PCC CURB AND GUTTER, TYPE 1-2	LF
701016	I.PCC CURB AND GUTTER, TYPE 1-4	LF
701017	I.PCC CURB AND GUTTER, TYPE 1-6	LF

ITEM	DESCRIPTION	UNIT
701018	I.PCC CURB AND GUTTER, TYPE 1-8	LF
701019	I.PCC CURB AND GUTTER, TYPE 2	LF
701020	I.PCC CURB AND GUTTER, TYPE 3-2	LF
701021	I.PCC CURB AND GUTTER, TYPE 3-4	LF
701022	I.PCC CURB AND GUTTER, TYPE 3-6	LF
701023	I.PCC CURB AND GUTTER, TYPE 3-8	LF
701025	PCC CURB TYPE 2 ROUNDABOUT	LF
701026	PCC MONOLITHIC MEDIAN	LF
701027	PCC CURB TYPE 1-2 ROUNDABOUT	LF
701031	CURB OPENING, 2’ OPENING	EACH
701032	CURB OPENING, 4’ OPENING	EACH
701033	PCC CURB, TYPE 1-2, MEDIAN GUARDRAIL	LF
701034	PCC CURB, LAYDOWN	LF

SECTION 702 — TRIANGULAR CHANNELIZING ISLANDS

702.1 Description.

This work consists of constructing triangular channelizing islands.

702.2 Materials.

A.	Bituminous Patching	Section 401
B.	Truncated Dome Detectable Warning Surfaces	Section 705
C.	Delineator	Section 1073.1
D.	Bituminous Pavement	Section 1014
E.	PCC, Class B	Section 1022
F.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7
G.	Expansion Joint Material	Section 1042.2.A

702.3 Construction.

A. Provide a concrete flatwork technician with an ACI or NRMCA certification, or a certification from another Department approved certification program, to supervise concrete finishing. Provide the certification to the engineer before placing concrete.

B. Place concrete in accordance with Section 501.3 including the weather limitations in Section 501.3.8.

C. Triangular Channelizing Island.

1. Saw cut existing bituminous concrete pavement or PCC pavement in accordance with Section 762.3 and:
   a. Saw cut pavement 18 inches from the proposed face of curb.
   b. With the approval of the engineer, the contractor may saw cut at the proposed face of the curb in locations adjacent to PCC pavement.
2. Remove bituminous concrete pavement, or PCC pavement, and dispose of in accordance with Section 202.
3. Prepare the foundation in accordance with Section 701.3.
4. Place GABC for curb placement at the location and depths shown on the plans in accordance with Section 301.3.
5. Layout and pour PCC Type 2 Curb in accordance with Section 701.3, unless otherwise specified on the plans.
6. Place concrete, joints, finish and cure PCC, and PCC curb and sidewalk in accordance with Section 701.3.
7. Backfill curb in accordance with Section 701.3, after removal of forms or upon completion of the slip-form operation.
8. Install the 4-inch PVC sleeve for signs at locations shown in the contract.

9. Construct pedestrian connections in accordance with the Standard Construction Details and modifications of the Standard Construction Details shown in the contract, and in accordance with Sections 302 and 705.
10. Provide and place Truncated Dome Detectable Warning Surface in accordance with the Standard Construction Details and Section 705.
11. Perform bituminous patching in accordance with Section 401 and PCC patching in accordance with Section 503 as shown in the contract or otherwise match the existing pavement structure.
12. Provide and install tubular marker delineators on all corners of the island and in accordance with Section 824.
    a. Provide 28-inch tall and 2-inch wide orange tubular markers unless otherwise specified in the contract or as directed by the engineer.
    b. Place the maker on the island surface parallel to the roadway surface. Do not place the tubular marker in the roadway.
13. Do not place curb and sidewalk monolithically unless otherwise directed by the contract or the engineer.

702.4 Method of Measurement.

The Department will measure the quantity of Triangular Channelizing Islands as the number of square feet, from face of curb to face of curb placed and accepted. The Department will measure Truncated Dome Detectable Warning Surface in accordance with Section 705.

702.5 Basis of Payment.

A. The Department will pay the quantity of Triangular Channelizing Islands at the contract unit price per square foot. Price and payment constitute full compensation for:
    1. Excavation within the template of the item including the foundation;
    2. removal and disposal of existing materials;
    3. foundation preparation;
    4. providing and placing all materials;
    5. compaction;
    6. providing forms and forming;
    7. supplying, placing, finishing, and curing PCC;
    8. constructing joints;
    9. expansion joint material;
    10. sealing;
    11. sign sleeves;
    12. construction of pedestrian connections within the limits of the island;
    13. backfill and backfilling;
    14. removal of surplus materials;

15. removal and replacement of cracked or damaged curb to the joints; and
16. providing and placing delineators.

B. The Department will pay for:

1. Excavation and embankment outside the template of the item in accordance with Section 202 at the direction of the engineer or contract;
2. rock removal in accordance with Section 202;
3. undercut excavation in accordance with Section 202;
4. Truncated Dome Detectable Warning Surface in accordance with Section 705;
5. PCC removal in accordance with Section 211;
6. saw cutting in accordance with Section 762;
7. GABC in accordance with Section 301; and
8. bituminous pavement patching in accordance with Section 401.

ITEM	DESCRIPTION	UNIT
702000	TRIANGULAR CHANNELIZING ISLANDS	SF

SECTION 705 — PCC SIDEWALK, PEDESTRIAN CONNECTIONS, AND DETECTABLE WARNING SURFACES

705.1 Description.

This work consists of constructing PCC sidewalk and pedestrian connections and placing Truncated Dome Detectable Warning Surfaces and Directional Tactile Surface Indicators.

705.2 Materials.

A.	PCC, Class B	Section 1022
B.	1/2-Inch Preformed Expansion Joint Material	Section 1042.2.A
C.	Bituminous Joint Sealant	Section 1042.2.B
D.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7
E.	Mortar	Section 1047.6

705.3 Construction

705.3.1 PCC Sidewalk and Pedestrian Connections.

A. Provide a concrete flatwork technician with an ACI or NRMCA certification, or a certification from another Department approved certification program, to supervise concrete finishing. Provide the certification to the engineer before placing concrete.

B. Place concrete in accordance with Section 501.3 with special attention to the weather limitations described in Section 501.3.8.

C. Construction of PCC Sidewalk and Pedestrian Connections.

1. Saw cut in accordance with Section 701.3.
2. Remove bituminous concrete pavement, or PCC pavement, and dispose of in accordance with Section 202.
3. Prepare the foundation in accordance with Section 701.3.
4. Place GABC at the location and depths shown in the contract and in accordance with Section 301.3.
5. Layout and place concrete in accordance with Section 701.3, unless otherwise specified in the contract.
6. Joints.
   a. Construct contraction joints by tool or saw cutting at a maximum width of 1/2-inch. Place at 5-foot intervals, with the exception of pedestrian connection items, when concrete has cured sufficiently.
   b. When there is sidewalk behind the curb, align curb joints to match sidewalk joints.
   c. Place Type IV polyurethane-bonded recycled rubber expansion joint in accordance with Section 701.3.G.
7. Finish and cure curb and sidewalk in accordance with Section 701.3.

8. Backfill sidewalk in accordance with Section 701.3, after removal of forms.
9. Install the 4-inch PVC sleeve for signs at locations shown in the contract.
10. Construct pedestrian connections in accordance with the requirements of the Standard Construction Details, any modifications of the Standard Construction Details shown on the plans, and to the requirements of Sections 302 and 705.
11. Provide and install detectable warning surfaces in accordance with the requirements of the Standard Construction Details and in accordance with Section 705.
12. Perform bituminous patching in accordance with Section 401, or PCC patching in accordance with Section 503 as shown on plans.
13. The curb and sidewalk components are not to be placed monolithically unless otherwise directed by the contract or the engineer.
14. Adhere to the requirements of Section 501.5.3 Low Strength Concrete Adjustments.
15. For cracked or damaged sidewalks, remove and replace the complete 5-foot sections between the joints.

705.3.2 Truncated Dome Detectable Warning Surface and Directional Tactile Surface Indicators.

A. Submit certification that the surface of the system is slip resistant, using 1 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).

B. Use the detectable warning surface pattern shown in the Standard Construction Details or indicated in the Plans.

C. Use 1 of the following material systems:
   1. Precast concrete;
   2. fired clay brick paver units; or
   3. cast iron plates manufactured with the detectable warning pattern, set in the concrete sidewalk surface.

D. Fill joints to within 1/4-inch of the surface, using a method approved by the engineer.

E. Anchor the cast iron plates to the sidewalk surface in accordance with the manufacturer's recommendations.

F. Do not use stamping systems, applied membranes, or ceramic tiles.

G. Provide a detectable warning surface color in accordance with the DelDOT 's Pedestrian Accessibility Standards for Facilities in the Public Right-of-Way Manual.

H. Construct the base material for the sidewalk section receiving the detectable warning system at a lower elevation so that the concrete under the detectable warning system is the same thickness as the adjacent sidewalk.

I. Place paver units so the surface is flush with the surrounding ramp and sidewalk surfaces.

K. Place the mortar in accordance with manufacturer's recommendations.

L. Set paver units in a bed of mortar for adhesion to the sidewalk surface.

1. Use mortar within 30-minutes after adding water. Do not retemper mortar by adding water.
2. Maintain 1/4-inch wide joints, no larger than 3/8-inch. The contractor may use plastic spacers.
3. Keep joints uniform and straight.

M. Maintain clean surfaces and joints.

N. The Department will allow a vertical edge for grade changes up to 1/4-inch.

O. Bevel edges of the system with grade changes in between 1/4-inches and 1/2-inches with a slope no steeper than 2 to 1.

P. For brick sidewalks, use precast concrete panels or fired brick paver units and:

1. Place units on the same base material and lift thickness as under the brick sidewalk.
2. Place units to achieve a flush surface with the surrounding ramp and sidewalk surfaces.

705.4 Method of Measurement.

705.4.1 Sidewalk.
The Department will measure the sidewalk quantity as square feet of sidewalk acceptably completed.

705.4.2 Truncated Dome Detectable Warning Surface.
The Department will measure the quantity of Truncated Dome Detectable Warning Surface as the number of square feet acceptably completed.

705.4.3 Directional Tactile Surface Indicators
The Department will measure the quantity of Directional Tactile Surface Indicators as the number of square feet acceptably completed.

705.4.4 Pedestrian Connections.
The Department will measure the quantity of pedestrian connections as the square feet of surface area of pedestrian connection acceptably completed. The Department will establish the area of pedestrian connections by measurement of the top of concrete curb (and gutter), sidewalk, and taper areas shown in the contract.

705.5 Basis of Payment.

705.5.1 Sidewalk.

A. The Department will pay the quantity for sidewalk at the contract unit price per square feet. Price and payment constitute full compensation for:

1. Excavation within the template of the item including the foundation;
2. removal and disposal of existing materials;
3. foundation preparation;
4. providing and placing all materials;
5. compaction;
6. forms and forming;
7. supplying, placing, finishing, and curing PCC;
8. joints;
9. expansion joint material;
10. sealing;
11. backfill and backfilling;
12. removing surplus materials; and
13. removing and replacing cracked or damaged sidewalk.

B. The Department will pay for:

1. Excavation and embankment outside the template of the item in accordance with Section 202 at the direction of the engineer or in accordance with the contract;
2. rock removal in accordance with Section 202;
3. undercut excavation in accordance with Section 202;
4. PCC removal in accordance with Section 211;
5. saw cutting in accordance with Section 762;
6. GABC in accordance with Section 301; and
7. bituminous pavement patching in accordance with Section 401.

705.5.2 Truncated Dome Detectable Warning Surface.

A. The Department will pay for the quantity of detectable warning surface at the contract unit price per square foot. Price and payment constitute full compensation for:

1. Providing and placing all materials;
2. installing Truncated Dome Detectable Warning Surface; and
3. joint sealing.

705.5.3 Directional Tactile Surface Indicators

A. The Department will pay for the quantity of Directional Tactile Surface Indicators at the contract unit price per square foot. Price and payment constitute full compensation for:

1. Providing and placing all materials;
2. installing directional tactile surface indicators; and
3. joint sealing.

705.5.4 Pedestrian Connections.

A. The Department will pay the quantity for Pedestrian Connections at the contract unit price per square feet. Price and payment constitute full compensation for:

1. Excavation within the template of the item including the foundation;
2. removal and disposal of existing materials;
3. foundation preparation;
4. providing and placing all materials;
5. compaction;
6. forms and forming;
7. supplying, placing, finishing, and curing PCC;
8. joints;
9. expansion joint material;
10. sealing;
11. backfill and backfilling;
12. removing surplus materials;
13. constructing and tapering curb required for pedestrian connection compliance; and
14. removing and replacing cracked or damaged sidewalk and DWS.

B. The Department will pay for:

1. Excavation and embankment outside the template of the item in accordance with Section 202 at the direction of the engineer or in accordance with the contract;
2. rock removal in accordance with Section 202;
3. undercut excavation in accordance with Section 202;
4. PCC removal in accordance with Section 211;
5. saw cutting in accordance with Section 762;
6. GABC in accordance with Section 301; and
7. bituminous pavement patching in accordance with Section 401.

ITEM	DESCRIPTION	UNIT
705001	PCC SIDEWALK, 4”	SF
705002	PCC SIDEWALK, 6”	SF
705005	PCC SIDEWALK, 8”	SF
705008	PEDESTRIAN CONNECTION, TYPE 1	SF
705009	PEDESTRIAN CONNECTION, TYPE 2, 3 AND/OR 4	SF
705010	PEDESTRIAN CONNECTION, TYPE 5	SF
705011	PEDESTRIAN CONNECTION, SPECIAL	SF

705012	DIRECTIONAL TACTILE SURFACE INDICATORS	SF
705013	TRUNCATED DOME DETECTABLE WARNING SURFACE	SF

SECTION 706 — MONUMENT

706.1 Description.

This work consists of setting PCC monuments and capped rebar right-of-way markers.

706.2 Materials.

A. PCC, Class B	Section 1022
B. Bar Reinforcement	Section 1037
C. Aluminum 2-Inch Flat Survey Marker	
D. Monument Delineators	
1. Wood	Section 1041
2. Flexible Delineator	Section 1073.4

706.3 Construction.

A. Monuments.

1. The engineer will provide the exact monument and right-of-way marker locations, set by a Delaware professional land surveyor, in accordance with the contract.
2. Place monuments vertically in excavated holes at the depths shown in the contract, with 2 sides approximately parallel with the roadway. Place backfill material in layers and firmly tamp without disturbing the location set by the surveyor.
3. Take care not to break or damage monuments when removing and resetting.
4. Replace broken or damaged monuments in kind.
5. Install delineators as required by the contract.

B. Capped Rebar Right-of-way Markers.

1. Place capped rebar right-of-way markers in accordance with the contract.
2. Place rebar vertically at the depth shown in the contract.
3. Place aluminum 2-inch flat survey markers on rebar taking care not to move the rebar location.
4. Install delineators as required by the contract.

C. Right of Way Marker Delineators

1. Place flexible delineators as indicated in the contract.
2. Install flexible delineators in accordance with manufacturer recommendations to a final top elevation of no less than 36-inches as measured from the ground surface elevation.
   a. Do not install delineators in frozen ground.
3. Affix vertical lettering to the top portion of the delineator.

706.4 Method of Measurement.

The Department will measure monuments and capped rebar right-of-way markers as the number placed and accepted.

706.5 Basis of Payment.

A. The Department will pay for the quantity of monuments and capped rebar right-of-way markers at the contract unit price per each placed. Price and payment constitute full compensation for:

1. Excavating;
2. backfilling;
3. providing and placing all materials; and
4. setting monument by a Delaware Professional Land Surveyor.

ITEM	DESCRIPTION	UNIT
706000	MONUMENT	EACH
706001	RELOCATE MONUMENT	EACH
706002	RIGHT-OF-WAY MARKER, CAPPED REBAR	EACH

SECTION 707 — RIPRAP

707.1 Description.

This work consists of riprap and channel bed fill construction.

707.2 Materials.

A.	Stone	Section 1006
B.	Bagged Riprap	Section 1030

707.3 Construction.

707.3.1 Pre-Sacked Concrete Riprap.

A. Protect pre-sacked concrete riprap from moisture using a waterproof covering if the contractor does not place the riprap the same day of delivery. The Department will reject bags containing material that has begun to hydrate.

B. Follow the manufacturer's recommendations for weather limitations.

C. Place geotextile in accordance with Section 708 and the contract.

D. Place pre-sacked riprap on slopes in accordance with the contract. Stagger the bagged riprap joints, in a regular pattern. Tamp into place to conform the riprap bags to the prepared slope and to adjacent bags already placed. Remove and replace all ripped or torn bags.

E. Wet the installation with water to initiate the cement hydration process in accordance with the manufacturer's recommendations. Wet each new course of bagged riprap thoroughly before placing the next course when the contract requires multiple courses. Do not use a paper pre-sacked rip rap product for underwater applications.

F. In multi-level construction, ensure that each surface is clean before placing the next layer of bags. Provide good bag-to-bag contact to ensure bonding in accordance with the manufacture's recommendations. Do not disturb the placed bags until the concrete has sufficiently cured.

707.3.2 Stone Riprap.

A. Excavation within the riprap area template.

B. Prepare the bedding area.

1. Level placement area without voids or cavities.
2. Ensure the area is free from stones 2-inches or larger, vegetation, debris, and soft material.
3. Preparation of the area may include: clearing and grubbing, excavating, removing unsuitable material, backfilling, and placing embankment.

C. Place geotextile in accordance with Section 708 and the contract.

D. Place the riprap carefully 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 that prevents segregation of stone sizes and prevents displacement of underlying material. Arrange individual stones to ensure a uniform distribution.

707.3.3 Channel Bed Fill

A. Place channel bed fill to the dimensions and at the locations shown on the plans.

707.4 Method of Measurement.

A. The Department will measure the quantity of pre-sacked concrete riprap as the number of cubic yards of riprap placed and accepted.

B. The Department will measure the quantity of stone riprap as either the number of square yards, cubic yards, or tons of riprap for each class placed and accepted. When the Department measures stone riprap by the square yard, the Department will determine the quantity by computations based on field measurements. The Department will take measurements along the completed finished surfaces, no horizontal projection, and the specified placement thickness for the class. When the Department measures stone riprap by the ton, the Department will determine weight in accordance with Section 109.1.

C. The Department will measure the quantity of channel bed fill as the number of cubic yards of material placed and accepted.

707.5 Basis of Payment.

A. The Department will pay for pre-sacked concrete riprap at the contract unit price per cubic yard. The Department will pay for stone riprap at the contract unit price per square yard, cubic yard, or ton. Price and payment will constitute full compensation for:

1. Preparing the bedding areas, including excavation and backfilling;
2. providing and placing all materials; and
3. removing and replacing rejected bags.

B. The Department will pay for channel bed fill at the contract unit price per cubic yard. Price and payment constitute full compensation for:

1. Providing and placing all materials;
2. salvaging and stockpiling;
3. hauling; and
4. removal and disposal of materials.

C. The Department will pay for geotextile in accordance with Section 708.

D. The Department will pay for excavation above the final top of riprap elevation with other excavation items on the contract.

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
707021	CHANNEL BED FILL	CY

SECTION 708 — GEOTEXTILES

708.1 Description.

This work consists of furnishing and placing geotextiles.

708.2 Materials.

Geotextile Section 1060

708.3 Construction.

A. Place the geotextile on a prepared base area in a loose, unstretched condition.

B. Join the adjacent fabric edges with a lock-type or chain-type stitch, folded seam, or overlap adjacent swaths of fabric a minimum of 12-inches.

C. Overlap the material from upstream over downstream and from upslope over downslope.

D. Anchor the fabric in place using securing pins or other acceptable methods. Do not leave the fabric uncovered for more than 2-weeks.

708.4 Method of Measurement.

The Department will measure the quantity of geotextile as the number of square yards for each type of geotextile placed and accepted. The Department will determine the quantity by computations based on field measurements taken along the outside perimeter of the area covered by the geotextile.

708.5 Basis of Payment.

The Department will pay the quantity of geotextile at the contract unit price per square yard. Price and payment will constitute full compensation for providing and placing all materials.

ITEM	DESCRIPTION	UNIT
708001	GEOTEXTILES, STABILIZATION	SY
708002	GEOTEXTILES, SEPARATION	SY
708003	GEOTEXTILES, RIPRAP	SY

SECTION 709 — UNDERDRAINS

709.1 Description.

This work consists of furnishing and constructing underdrains.

709.2 Materials.

A.	Borrow, Type C	Section 1001
B.	Stone, Delaware No. 57	Section 1004
C.	Polyethylene Pipe	Section 1031
	1. AASHTO Class 2 Perforation Pattern	
D.	Geotextile	Section 1060
E.	Delineator	OM-2-2V Blue Reflector
F.	PCC	Section 1022
G.	Sign Post	Section 1072
H.	Rodent screen	Galvanized steel screen - 1/2-inch by 1/2-inch mesh and 0.063-inch diameter galvanized steel wires.

709.3 Construction.

A. Place the pipe in accordance with the contract and the Standard Construction Details. Make lateral connections to the pipe with connectors recommended by the manufacturer.

B. Backfill perforated pipe underdrain trench with stone backfill in 6-inch lifts and consolidate to the satisfaction of the engineer.

C. Backfill underdrain outlet pipe trenches and outlet structures in accordance with Section 207.3.D. Use Borrow, Type C material at least 1-foot over the underdrain outlet pipe. The contractor may use excavated material for backfill above any of the Borrow, Type C in areas outside of the roadway and shoulders, provided that the excavated material meets Borrow, Type F.

D. Video the entire underdrain system before placement of the final layer of roadway pavement material. If placing guardrail within 3-feet of the underdrain, video that section of the underdrain after guardrail installation.

E. Install the outfall delineator in accordance with contract documents.

709.4 Method of Measurement.

709.4.1 Perforated Pipe.
The Department will measure the quantity of perforated pipe underdrains from end-to-end as the linear feet of pipe completed and accepted.

709.4.2 Underdrain Outlet Pipe.
The Department will measure the quantity of underdrain outlet pipe from end-to-end as the linear feet of pipe completed and accepted.

709.4.3 Underdrain Outlet.
The Department will measure the quantity of underdrain outlets as the number of outlets installed and accepted.

709.5 Basis of Payment.

709.5.1 Perforated Pipe.

A. The Department will pay the quantity of perforated pipe underdrains at the contract unit price per linear foot. Price and payment will constitute full compensation for:

1. Providing and placing all materials;
2. constructing perforated pipe drains;
3. excavating, backfilling, compacting; and
4. video inspection.

709.5.2 Underdrain Outlet Pipe.

A. The Department will pay the quantity of underdrain outlet pipe at the contract unit price per linear foot. Price and payment will constitute full compensation for:

1. Providing and placing all materials;
2. constructing underdrain outlet pipe;
3. excavating, backfilling, compacting; and
4. video inspection.

709.5.3 Underdrain Outlet.

A. The Department will pay the quantity of underdrain outlets at the contract unit price of each. Price and payment will constitute full compensation for:

1. Providing and placing all materials;
2. delineator, including sign post, reflector, and hardware; and
2. excavating, backfilling and compacting.

709.5.4 Rock Excavation.
If rock is encountered during excavation for perforated pipe underdrain, outlet pipe, or outlet, the Department will pay for rock excavation in accordance with 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

ITEM	DESCRIPTION	UNIT
709011	UNDERDRAIN OUTLET PIPE, 6”	LF
709012	UNDERDRAIN OUTLET PIPE, 8”	LF
709014	UNDERDRAIN OUTLET PIPE, 12”	LF
709015	UNDERDRAIN OUTLET PIPE, 15”	LF
709016	UNDERDRAIN OUTLET PIPE, 24”	LF
709017	UNDERDRAIN OUTLET	EA

SECTION 710 — WATER SERVICES

710.1 Description.

This work consists of placing or relocating water services.

710.2 Materials.

A. Use materials specified in the contract and in accordance with the utility owner's specifications. The utility owner has the right to inspect materials and reject any materials that do not meet the utility owner's specifications.

B.	Stone	Section 1005
C.	PCC	Section 1022 or 1023
D.	Reinforcing Steel	Section 1037
E.	Pipe	Section 1031

710.3 Construction.

A. Perform the work in accordance with the contract and the utility owner's specifications. In cases of conflict between the contract and the utility owner's specifications, the utility owner's specifications take precedence.

B. Adjusting water services within pavement.

1. Saw cut existing bituminous concrete or PCC pavement a minimum of 2-feet from the face of the utility service.
2. Excavate materials from the perimeter in accordance with Section 207.3. Dispose of waste materials in accordance with Section 106.8.
3. Remove existing castings. Clean and set castings aside for reuse or replacement in accordance with the contract. If the engineer determines the casting is damaged and not suitable for reuse, provide a new casting as provided by the utility owner.
4. Place forms for the top unit.
5. Do not place the frame on bricks, blocks, or other materials.
6. Place required steel reinforcement and encase in PCC, Class B.
7. Dispose of removed utility as directed by the utility owner.

C. Pavement Patching.

1. Prepare subgrade for patching to match contract documents or the existing pavement section.
2. Provide bituminous patching material in accordance with Section 401.
3. Seal all patches in accordance with Section 504.

710.3.1 Special Requirements.

A. Perform the work in accordance with these specifications, the Standard Construction Details, the DelDOT Utilities Manual, and the utility owner's specifications. The utility owner's specifications

will take precedence over the Department's specifications in the event of a conflict between the 2 sets of specifications.

B. Coordinate water service construction activities with the utility owner. Provide the utility owner with reasonable time to respond to requests for information and coordination. Submit a plan for the planned sequence of water service shutdowns and tie-ins for approval at least 3-weeks before the planned start of work or as required by the utility owner.

C. The utility owner and the engineer will determine the times that the work can occur and the sequence of the work. Begin work after both the utility owner and the engineer grant permission to proceed. Notify the utility owner a minimum of 48-hours before beginning work. Notify both the engineer and the utility owner of all delays to the scheduled work.

D. Do not disrupt the operation of the existing water facilities without the utility owner's prior approval. Construct, disinfect, maintain, and remove following construction, temporary water bypasses used during construction to maintain water service.

E. Guarantee the work for a period determined by the utility owner after the date of completion and acceptance of the work and provide any repair work necessary during that period of time.

710.3.2 Excavation.

Excavate in accordance with Section 207, except as amended here. Excavate pipe trenches that provide bearing for the full length of the pipes. Excavate trenches for water service connections to the minimum standard depth required by the utility owner's specifications or to such depth as required to connect to existing mains or service pipes.

710.3.3 Installation.

A. Do not place pipe on a frozen foundation or if frost is likely to penetrate the bottom of an excavation. Keep excavations free from water or other liquids during the progress of the work. Backfill trenches in accordance with Section 207.

B. Clean all pipes, fittings, valves, hydrants, and appurtenances thoroughly before placement. Perform work only under the supervision of the utility owner's inspector.

C. Close the end of each open pipe at the end of each workday in accordance with the utility specifications.

710.3.4 Pressure Testing and Connection.

Pressure test and connect pipes in accordance with the utility owner specifications.

710.3.5 Sterilization of Main, Line, Laterals, and Accessories.

Sterilize the installed system using 1 of the procedures from AWWA Standard C601-81, and as required by the utility owner specifications. Perform sterilization with the plugs used in the pressure test still in place. Make the final connection of the new pipe to the existing water main only after a successful sterilization test.

710.3.6 As-Built Plans.

Prepare and submit as-built plans in accordance with The Department and Utility owner requirements.

710.4 Method of Measurement.

A. The Department will measure the quantity of adjusted and repaired existing water services as the number of each adjusted or repaired and accepted.

B. The Department will measure the quantity of the water service and accessory items either by linear foot or each.

710.5 Basis of Payment.

A. Price and payment will constitute full compensation for providing and placing all materials, excavating, backfilling, and compacting. The Department will consider saw cutting existing bituminous concrete or PCC pavement and disposing of waste materials as incidental to the work and will make no separate payment for saw cutting or disposing of materials.

B. Price and payment for water pipe items includes:

1. Providing and placing the materials;
2. adjusting, relocating, or repairing the services;
3. testing the water main system;
4. repairing leaks and defects;
5. connecting to existing water main systems and services;
6. maintaining service during the work;
7. excavating;
8. disposing of excess excavated material;
9. backfilling;
10. concrete thrust blocks;
11. joint restraints;
12. pipe bedding;
13. shoring;
14. temporary support of existing utilities;
15. dewatering;
16. steel and PCC required for encasement;
17. abandoning existing pipes;
18. cutting and capping new or existing lines; and
19. as-built preparation and collection.

C. The Department will pay for providing borrow material in accordance with Section 209.

D. The Department will make no separate payment for temporary bypasses. Emergency repairs are the contractor's responsibility. Upon notification by telecommunication from the utility owner, attend to repairs immediately. In the event the utility owner is unable to contact the contractor, or the contractor fails to make the emergency repairs in a length of time determined by the utility owner, the utility owner reserves the right to perform the emergency repair work. In such a case, reimburse the utility owner for the costs of the repairs.

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	PROVIDING AND INSTALLING WATER MAINS AND FITTINGS	LF
710039	PROVIDING AND INSTALLING HDPE WATER MAIN VIA DIRECTIONAL DRILL	LF
710040	PROVIDING 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

ITEM	DESCRIPTION	UNIT
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" X 8"	EACH
710106	CROSS 10" X 10"	EACH
710107	CROSS 12" X 12"	EACH
710108	CROSS 16" X 8"	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

ITEM	DESCRIPTION	UNIT
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" X 8"	EACH
710127	INCREASER, 8" X 10"	EACH
710128	INCREASER, 10" X 12"	EACH
710129	INCREASER, 12" X 16"	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

ITEM	DESCRIPTION	UNIT
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" X 4"	EACH
710187	M.J. REDUCER, 8" X 3"	EACH
710188	M.J. REDUCER, 8" X 4"	EACH
710189	M.J. REDUCER, 8" X 6"	EACH
710190	M.J. REDUCER, 10" X 8"	EACH
710191	M.J. REDUCER, 12" X 10"	EACH
710192	M.J. REDUCER, 12" X 6"	EACH
710193	M.J. REDUCER, 12" X 8"	EACH
710194	M.J. REDUCER, 14" X 12"	EACH
710195	M.J. REDUCER, 16" X 10"	EACH
710196	M.J. REDUCER, 16" X 12"	EACH

ITEM	DESCRIPTION	UNIT
710197	M.J. REDUCER, 20" X 12"	EACH
710198	M.J. REDUCER, 20" X 16"	EACH
710199	M.J. REDUCER, 24" X 6"	EACH
710200	M.J. REDUCER, 24" X 12"	EACH
710201	M.J. REDUCER, 24" X 16"	EACH
710202	M.J. REDUCER, 24" X 20"	EACH
710203	M.J. REDUCER, 24" X 24"	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" X 3"	EACH
710209	M.J. TEE, 8" X 4"	EACH
710210	M.J. TEE, 8" X 8" X 8"	EACH
710211	M.J. TEE, 12" X 12" X 10"	EACH
710212	M.J. TEE, 12" X 12" X 8"	EACH
710213	M.J. TEE, 12” X 12" X 12"	EACH
710214	M.J. TEE, 16" X 16" X 10"	EACH
710215	M.J. TEE, 16" X 16" X 12"	EACH
710216	M.J. TEE, 16" X 16" X 16"	EACH
710217	M.J. TEE, 16" X 16" X 8"	EACH
710218	M.J. TEE, 20" X 20" X 12"	EACH
710219	M.J. TEE, 20" X 20" X 20"	EACH
710220	M.J. TEE, 24" X 24" X 12"	EACH
710221	M.J. TEE, 4" X 4" X 1 1/2"	EACH
710222	M.J. TEE, 4" X 4" X 2"	EACH
710223	M.J. TEE, 4" X 4" X 4"	EACH
710224	M.J. TEE, 6" X 6" X 6"	EACH
710225	M.J. TEE, 8" X 8" X 6"	EACH
710226	M.J. WYE, 6" X 6" X 6"	EACH
710227	OFFSET 6" X 6"	EACH
710228	PRESSURE REDUCING VALVE	EACH
710229	PVC BENDS 45 DEGREES, 2"	EACH
710230	PVC REDUCER, 4" X 12"	EACH
710231	PVC RESTRAINER, 12"	EACH
710232	PVC SERVICE LINE, CLASS 200, 2"	LF
710233	REDUCER, 10" X 6"	EACH
710234	RESILIENT WEDGE VALVE, 6"	EACH
710235	RESILIENT WEDGE VALVE, 8"	EACH

ITEM	DESCRIPTION	UNIT
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 " X 2"	EACH
710253	TEE, 4" X 2" X 4"	EACH
710254	TEE, 6" X 6"	EACH
710255	TEE, 8" X 6"	EACH
710256	TEE, 8" X 8"	EACH
710257	TEE, 8" X 8" X 4"	EACH
710258	TEE, 10" X 10"	EACH
710259	TEE, 10" X 10" X 6"	EACH
710260	TEE, 10" X 10" X 8"	EACH
710261	TEE, 10" X 10" X 4"	EACH
710262	TEE, 12" X 12"	EACH
710263	TEE, 12" X 4"	EACH
710264	TEE, 12" X 6"	EACH
710265	TEE, 16" X 6"	EACH
710266	TEE, 16" X 8"	EACH
710267	TEE, 16" X 12"	EACH
710268	TEE, 12" X 12" X 8"	EACH
710269	TEE, 16" X 16" X 6"	EACH
710270	TEE, 16" X 16" X 8"	EACH
710271	TEE, 16" X 16" X 12"	EACH
710272	TEE, 16" X 16" X 16"	EACH
710273	TEE, 20" X 20" X 20"	EACH
710274	TEE, 24" X 24" X 16"	EACH

ITEM	DESCRIPTION	UNIT
710275	TEE, 24" X 24" X 24"	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

ITEM	DESCRIPTION	UNIT
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
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

ITEM	DESCRIPTION	UNIT
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" X 6"	EACH
710440	HYDRANT TEE, 8" X 6"	EACH
710441	HYDRANT TEE, 10" X 6"	EACH
710442	HYDRANT TEE, 12" X 6"	EACH
710443	HYDRANT TEE, 16" X 6"	EACH
710444	HYDRANT TEE, 20" X 6"	EACH
710445	HYDRANT TEE, 24" X 6"	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" X 6"	EACH
710461	TAPPING SLEEVE AND VALVE, 8" X 6"	EACH
710462	TAPPING SLEEVE AND VALVE, 8" X 8"	EACH
710463	TAPPING SLEEVE AND VALVE, 8" X 12"	EACH
710464	TAPPING SLEEVE AND VALVE, 10" X 10"	EACH
710465	TAPPING SLEEVE AND VALVE, 10" X 6"	EACH
710466	TAPPING SLEEVE AND VALVE, 10" X 8"	EACH
710467	TAPPING SLEEVE AND VALVE, 10" X 10"	EACH
710468	TAPPING SLEEVE AND VALVE, 10" X 12"	EACH
710469	TAPPING SLEEVE AND VALVE, 12" X 12"	EACH
710470	TAPPING SLEEVE AND VALVE, 12" X 16"	EACH
710471	TAPPING SLEEVE AND VALVE, 16" X 6"	EACH
710472	TAPPING SLEEVE AND VALVE, 16" X 16"	EACH
710473	TAPPING SLEEVE AND VALVE, 20" X 20"	EACH
710474	TAPPING SLEEVE AND VALVE, 24" X 16"	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	EACH
710485	DEWATERING RISER	EACH

ITEM	DESCRIPTION	UNIT
710486	DISINFECTION TAP	EACH
710487	METER AND METER YOKE, 1" X 1"	EACH
710488	METER YOKE, 3/4" X 5/8"	EACH
710489	MICRO-TUNNELING	LF
710490	PVC METER BOX WITH C.I. COVER, 18" X 24"	EACH
710491	RELOCATING WATER METER	EACH

SECTION 711 — SANITARY SEWER SYSTEM

711.1 Description.

This work consists of constructing sanitary sewer systems.

711.2 Materials.

A. Use materials specified in the contract and in accordance with the utility owner's specifications. The utility owner has the right to inspect materials and reject any materials that do not meet the utility owner's specifications.

B.	Borrow	Section 1001
C.	Stone	Section 1005
D.	PCC	Section 1022 or 1023
E.	Reinforcing Steel	Section 1037
F.	Pipe	Section 1031

G. Unless shown otherwise in the contract or required by the utility owner, use the same class of material as the existing sewer mains for construction of commercial, industrial, and residential connections.

711.3 Construction.

A. Perform the work in accordance with the contract and the utility owner's specifications. In cases of conflict between the contract and the utility owner's specifications, the utility owner's specifications take precedence.

B. Adjusting Sanitary Sewer Services Within Pavement.

1. Saw cut existing bituminous concrete or PCC pavement a minimum of 2-feet from face of the utility service.
2. Excavate materials from the perimeter in accordance with Section 207.3. Dispose of waste materials in accordance with Section 106.8.
3. Remove existing castings. Clean and set castings aside for reuse or replacement in accordance with the contract. If the engineer determines the casting is damaged and not suitable for reuse, provide a new casting as provided by the utility owner.
4. Place forms for the top unit.
5. Do not place the frame on bricks, blocks, or other materials.
6. Place required steel reinforcement and encase in PCC, Class B.
7. Dispose of removed utility as directed by the utility owner.

C. Pavement Patching.

1. Prepare subgrade for patching to match contract documents or the existing pavement section.
2. Provide bituminous patching material in accordance with Section 401.
3. Seal all patches in accordance with Section 504.

711.3.1 Special Requirements.

A. Perform the work in accordance with these specifications, the Standard Construction Details, the DelDOT utility manual, and the utility owner's specifications. The utility owner's specifications will take precedence over the Department's specifications in the event of a conflict between the 2 sets of specifications.

B. Coordinate sanitary sewer service construction activities with the utility owner. Provide the utility owner with reasonable time to respond to requests for information and coordination. Submit a plan for the planned sequence of sanitary sewer service shutdowns and tie-ins for approval at least 3-weeks before the planned start of work or as required by the utility owner.

C. The utility owner and the engineer will determine the times that the work can occur and the sequence of the work. Begin work only after obtaining the engineer's permission. Notify the utility owner a minimum of 48-hours before beginning work. Notify both the engineer and the utility owner of delays to the scheduled work.

D. Do not disrupt the operation of the existing sanitary sewer facilities without prior approval of the utility owner. Construct, maintain, and remove temporary sanitary sewer bypasses used during construction to maintain sanitary sewer service.

E. Guarantee the work for a period determined by the utility owner after the date of completion and acceptance of the work and provide all repair work necessary during that period of time.

711.3.2 Excavation.

Excavate in accordance with Section 207, except as amended here. Excavate pipe trenches that provide bearing for the full length of the pipes. Excavate trenches for sanitary sewer service connections to the minimum standard depth required by the utility owner's specifications or to such depth as required to connect to existing mains or service pipes.

711.3.3 Installation.

A. Do not place pipe on a frozen foundation or if frost is likely to penetrate the bottom of an excavation. Keep excavations free from water or other liquids during the progress of the work. Backfill trenches in accordance with Section 207.

B. Clean all pipes, fittings, valves, and appurtenances thoroughly before placement. Perform work only under the supervision of the utility owner's inspector.

C. Close the end of each open pipe at the end of each workday in accordance with the utility owner's specifications.

711.3.4 Acceptance Testing and Connection.

Test and connect pipe in accordance with the utility owner's specifications.

711.3.5 As-Built Plans.

Prepare and submit as-built plans in accordance with The Department and Utility owner requirements.

711.4 Method of Measurement.

A. The Department will measure the quantity of adjusted and repaired existing sanitary sewer services as the number of each adjusted or repaired and accepted.

B. The Department will measure the quantity of sanitary sewer items by linear foot or each as placed and accepted. The Department will measure sanitary sewer laterals adjustments as the actual number of laterals adjusted and accepted.

711.5 Basis of Payment.

A. Price and payment will constitute full compensation for providing and placing all materials, excavating, backfilling, and compacting. The Department will consider saw cutting existing bituminous concrete or PCC pavement and disposing of waste materials as incidental to the work and will make no separate payment for saw cutting or disposing of materials.

B. Price and payment for sanitary sewer system items, including adjustment of sanitary sewer laterals, includes:

1. Providing and placing materials;
2. testing the sanitary sewer system;
3. connections;
4. maintaining service during construction;
5. excavating;
6. disposing of excess excavated material;
7. backfilling and backfill material;
8. providing and placing warning tape;
9. aggregate pipe bedding;
10. shoring;
11. temporary support of existing utilities;
12. dewatering;
13. tanker trucks and pumps;
14. disposing of excess flow;
15. steel and PCC required for encasement; and
16. as-built preparation and collection.

C. The Department will make no separate payment for temporary bypasses. Emergency repairs are the contractor's responsibility. Upon notification by telecommunication from the utility owner, attend to repairs immediately. In the event the utility owner is unable to contact the contractor, or the contractor fails to make the emergency repairs in a length of time determined by the utility owner, the utility owner reserves the right to perform the emergency repair work. In such a case, reimburse the utility owner for the costs of the repairs.

ITEM	DESCRIPTION	UNIT
711001	ADJUST SANITARY SEWER LATERALS	EACH
711002	SANITARY SEWER SYSTEM	LS
711003	SANITARY AND WATER FACILITY	LS

ITEM	DESCRIPTION	UNIT
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

ITEM	DESCRIPTION	UNIT
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

720.1 Description.

This work consists of constructing guardrails.

720.2 Materials.

A.	PCC, Class B	Section 1022
B.	Steel Posts, Steel Shapes	Section 1070
C.	Galvanized Beam Guardrail	Section 1070
D.	Guardrail Hardware	Section 1070
E.	Guardrail Reflectors	Section 1070
F.	Timber Posts	Section 1070
G.	Offset Blocks	
1.	Wood	Section 1070
2.	Recycled Composite Materials	
a.	As specified by the manufacturer	
b.	Selected from the Approved Products List (https://www.deldot.gov/Business)	
H.	Galvanized Steel Pipe	Section 1070

720.3 Construction.

A. Conduct a pre-installation field meeting prior to placement of guardrail systems if required by the engineer or noted in the contract.

B. Before installation, provide shop drawings for guardrail components not provided in the contract including the associated manufacturer's installation instructions.

C. Provide and install guardrail and components in accordance with the Contract.

720.3.1 Post Installation.

A. Dig test pits to determine utility and storm sewer conflicts before post placement in accordance with Section 204. Repair damage to subsurface facilities caused by post installation.

B. The Department will allow the driving method for post placement. Seal posts with material approved by the engineer.

C. If the driving method is not used, excavate post holes of sufficient diameter to allow tamping of backfill around the posts. Backfill with approved material. Place backfill in compaction lifts not exceeding 6-inches of uncompacted material.

D. Align the posts to within 1/4-inch of line and grade before installing rail elements. Install posts plumb. Repair bituminous concrete that cracks or breaks resulting from post installations in accordance with Section 401.

720.3.2 Rail Assembly.

A. Lap rails in the direction of traffic flow for the closest lane. Draw tight all bolts except those through expansion joints. Tighten bolts through expansion joints as tight as possible without preventing the beams from sliding past one another longitudinally. Extend bolts at least 1/4-inch beyond the nuts. Do not extend bolts necessary for adjustment more than 1/2-inch beyond the nuts. Burr the last thread of post railing bolts to prevent removal.

B. Do not field cut holes in rails unless otherwise directed in the contract. If holes must be field cut, mechanically punch or drill them. Remove all burs created by field cutting activities from the rail.

720.3.3 Offset Blocks.

A. Install new guardrail, using either wood or approved recycled composite offset blocks. Do not mix different types of manufactured composite blocks or mix composite and wood blocks. Do not install composite offset blocks at wood posts.

B. Notch wood offset blocks in accordance with the Standard Construction Details only when installing on steel posts. When installing wood offset blocks on wood posts, toenail the wood offset block in place using a 3-inch long ceramic coated screw. Place the screw so that it penetrates both the wood offset block and wood post.

C. Install approved recycled composite offset blocks in accordance with the manufacturer's recommendations with no modifications.

720.3.4 Guardrail Reflectors.

A. Install guardrail reflectors in accordance with the Standard Construction Details.

720.3.5 Relocating Guardrail.

A. Remove existing guardrail in a manner that prevents damage. Replace hardware with new hardware.

B. Reinstall and reset the guardrail system at the locations designated in the contract and in accordance with Section 720.3, and the Standard Construction Details. If the existing guardrail has steel offset blocks, replace the offset blocks with offset blocks meeting the requirements of Section 1070 and the Standard Construction Details. Install new guardrail reflectors in accordance with Section 720.3.4.

720.3.6 Guardrail Over Culvert.

Provide and install guardrail over culvert in accordance with the Standard Construction Details.

720.4 Method of Measurement.

A. The Department will measure:

1. Guardrail from the center of end post to the center of end post, excluding barrier connections and end treatments;
2. guardrail components as the number of each component provided, placed, and accepted by limit of payment;
3. guardrail over culverts as the number of each provided, placed, and accepted by limit of payment;
4. relocated guardrail as the number of linear feet of guardrail relocated and accepted.

720.5 Basis of Payment.

A. The Department will pay the quantity of guardrail installations, guardrail components, replacing individual components, relocating guardrail, or guardrail over culverts at the contract unit price. New beam guardrail installation includes all posts, beams, hardware, and components. Price and payment will constitute full compensation for:

1. Pre-installation field meeting;
2. test pits;
3. providing and placing materials and components;
4. fabricating;
5. excavating;
6. required transition sections;
7. guardrail reflectors;
8. burring bolts;
9. backfilling;
10. grading;
11. compacting;
12. disposing of surplus materials and components; and
13. patching material around posts.

B. The Department will not pay for repairing damaged subsurface facilities caused by post installation.

ITEM	DESCRIPTION	UNIT
720001	GALVANIZED STEEL BEAM GUARDRAIL (WOOD POST)	LF
720002	GUARDRAIL TO BRIDGE GUARDRAIL TRANSITION	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
720017	GALVANIZED RAIL ELEMENT	EACH
720018	GALVANIZED STEEL POST, 7'	EACH

ITEM	DESCRIPTION	UNIT
720019	GALVANIZED STEEL POST, 8'	EACH
720020	GUARDRAIL REFLECTOR	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
720025	GUARDRAIL OVER CULVERTS, TYPE 2-31	EACH
720026	GUARDRAIL OVER CULVERTS, TYPE 3-31	EACH
720028	CURVED GUARDRAIL SECTION	LF
720030	RELOCATING GUARDRAIL	LF
720032	REMOVE AND RESET GALVANIZED STEEL POST AND OFFSET BLOCK	EACH
720033	OFFSET BLOCKS	EACH
720034	GALVANIZED STEEL BEAM GUARDRAIL, TYPE 1-27	LF
720035	GALVANIZED STEEL BEAM GUARDRAIL, TYPE 2-27	LF
720036	GALVANIZED STEEL BEAM GUARDRAIL, TYPE 3-27	LF
720037	GALVANIZED STEEL BEAM GUARDRAIL, TYPE 1-31, STEEP SLOPE	LF
720038	LONG WOOD BREAKAWAY POST, TREATED	EACH

SECTION 721 — GUARDRAIL END SECTIONS AND TRANSITIONS

721.1 Description.

This work consists of guardrail end sections, end anchorages, buried end sections, guardrail to barrier connections, and guardrail transition sections.

721.2 Materials.

A. Guardrail End Treatment.

1. Provide guardrail end treatment, selected from the Approved Products List (https://www.deldot.gov/Business). Before installation, provide a submittal for guardrail end treatment including the associated manufacture's installation instruction for the end treatment selected. Use guardrail end treatment designs as follows:
   a. Type 1 – tangent end treatment.
   b. Type 2 – flared end treatment.
   c. Type 3 – median end treatment.
2. Provide with retroreflective material on the nose of the guardrail end treatment as follows:
   a. Type 1
      i. 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 will pass.
   b. Type 2
      i. 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 will pass.
   c. Type 3
      i. A marker consisting of ASTM D4956 Type IV retroreflective yellow sheeting covering the nose of the end treatment.
   d. Type 4-27
      i. A minimum of 3-square feet.
      ii. 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 will pass.

B. Guardrail End Anchorage.	Section 720.2
C. Buried End Section.	Section 720.2
D. Guardrail to Barrier Connection.	Section 720.2
E. Non-Shrink Grout	Section 1047.2
F. Bullnose End Treatment	Section 720.2
G. Galvanized Steel Rub Rail	Section 1070

721.3 Construction.

A. If required by the engineer or by the contract, conduct a pre-installation field meeting before installing guardrail systems.

B. Before installation, provide shop drawings for guardrail components not provided in the contract, including the associated manufacturer's installation instructions.

C. Provide and install guardrail end sections, transitions, and components in accordance with the contract.

721.3.1 Post Installation.

A. Dig test pits to determine utility conflicts before post placement in accordance with Section 204.

B. The Department will allow the driving method for post placement. Seal posts with material approved by the engineer.

C. If the driving method is not used, excavate post holes of sufficient diameter to allow tamping of backfill around the posts. Backfill with approved material. Place backfill in compaction lifts not exceeding 6 inches of uncompacted material.

D. Align the posts to within 1/4-inch of line and grade before installing rail elements. Install posts plumb. Repair bituminous concrete that cracks or breaks resulting from post installations in accordance with Section 401.

721.3.2 Guardrail End Treatment.

Assemble and place the guardrail end treatment in accordance with the manufacturer's recommendations. Grade in accordance with the manufacturer's recommendations. Place only guardrail reflectors on the end treatment specified by the manufacturer. Affix the required retroreflective material to the nose of the guardrail end treatment. Construct guardrail end treatment using applicable construction methods provided in Section 720.3.

721.3.3 Guardrail End Anchorage.

Install guardrail end anchorages in accordance with the Standard Construction Details. Construct end anchorages using applicable construction methods provided in Section 720.3.

721.3.4 Buried in Back Slope and Entrance Special End Anchorage.

Install buried end sections in accordance with the Standard Construction Details. Construct buried end sections using applicable construction methods provided in Section 720.3.

721.3.5 Guardrail to Barrier Connection.

Install approach type or exit type guardrail-to-barrier connections in accordance with the Standard Construction Details. Construct guardrail-to-barrier connections using applicable construction methods provided in Section 720.3. Fill existing holes in concrete barrier with non-shrink grout.

721.4 Method of Measurement.

721.4.1 Guardrail End Treatments.

The Department will measure the quantity of guardrail end treatments as the number provided, assembled, placed, and accepted. The Department will define the limit of payment in the Standard Construction Details for the type of end treatment installed.

721.4.2 Guardrail End Anchorages, Entrance Special End Anchorages, Buried in Back Slope, Guardrail to Barrier Connection.

The Department will measure the quantities of guardrail end anchorages, entrance special end anchorages, buried in back slope, and guardrail to barrier connections as the number provided, assembled, placed, and accepted.

721.5 Basis of Payment.

721.5.1 Guardrail End Treatment.

A. The Department will pay the quantity of guardrail end treatments at the contract unit price. Price and payment will constitute full compensation for:

1. Pre-installation field meeting;
2. test pits;
3. shop drawings
4. provide and place materials and components in accordance with the manufacturer's installation instructions;
5. fabricating;
6. excavating;
7. burring of bolts;
8. backfilling;
9. grading;
10. compacting;
11. disposing of surplus materials and components; and
12. patching material around posts.

721.5.2 Guardrail End Anchorage.

A. The Department will pay the quantity of guardrail end anchorages at the contract unit price per each. Price and payment will constitute full compensation for:

1. Pre-installation field meeting;
2. test pits;
3. providing and placing materials and components;
4. fabricating;
5. excavating;
6. burring of bolts;
7. backfilling;
8. grading;
9. compacting;
10. disposing of surplus materials and components; and

11. patching material around posts.

721.5.3 Buried in Back Slope and Entrance Special End Anchorage.

A. The Department will pay the quantity of buried end sections and entrance special end anchorage at the contract unit price per each. Price and payment will constitute full compensation for:

1. Pre-installation field meeting;
2. test pits;
3. providing and placing materials and components;
4. fabricating;
5. excavating;
6. constructing anchorage block;
7. burring of bolts;
8. backfilling;
9. grading;
10. compacting;
11. disposing of surplus materials and components; and
12. patching material around posts.

721.5.4 Guardrail to Barrier Connection.

A. The Department will pay the quantity of guardrail to barrier connections at the contract unit price per each. Price and payment will constitute full compensation for:

1. Pre-installation field meeting;
2. test pits;
3. providing and placing materials and components;
4. fabricating;
5. excavating;
6. guardrail reflectors;
7. burring of bolts;
8. backfilling;
9. compacting;
10. disposing of surplus materials;
11. patching material around posts;
12. repairing damage to the concrete barrier from attaching the guardrail to the barrier; and
13. filling any existing holes in the barrier with non-shrink grout.

ITEM	DESCRIPTION	UNIT
721000	GUARDRAIL END TREATMENT, TYPE 1-31, TEST LEVEL 2	EACH
721001	GUARDRAIL END TREATMENT, TYPE 1-31, TEST LEVEL 3	EACH
721002	GUARDRAIL END TREATMENT, TYPE 2-31, TEST LEVEL 2	EACH
721003	GUARDRAIL END TREATMENT, TYPE 2-31, TEST LEVEL 3	EACH
721004	GUARDRAIL END TREATMENT, TYPE 3-31	EACH
721005	GUARDRAIL END TREATMENT, TYPE 4-27	EACH
721006	END ANCHORAGE 31	EACH
721007	ENTRANCE SPECIAL END ANCHORAGE	EACH
721008	BURIED IN BACK SLOPE	EACH
721009	GUARDRAIL TO BARRIER CONNECTION (EXIT TYPE 31)	EACH
721010	GUARDRAIL TO BARRIER CONNECTION, APPROACH TYPE 1-31	EACH
721012	GUARDRAIL TO BARRIER CONNECTION, APPROACH TYPE 3-31	EACH
721013	GUARDRAIL TO CONCRETE MEDIAN BARRIER TRANSITION	EACH
721017	BULLNOSE END TREATMENT	EACH

SECTION 722 — HIGH-TENSION CABLE BARRIER

722.1 Description.

This work consists of constructing high-tension cable barrier (HTCB).

722.2 Materials.

A. Provide a HTCB with the following capabilities and features:

1. Crashworthy on level terrain in accordance with the latest MASH testing requirements for a Test Level 4 (TL-4) installation.
2. Crashworthy on a 4:1 sloped terrain in accordance with the latest MASH testing requirements for a Test Level 3 (TL-3) installation.
3. Compatible with a crashworthy cable end terminal in accordance with the latest MASH testing requirements for a Test Level 3 (TL-3) installation.
4. Galvanized steel posts Section 1070
   a. Rust inhibitor coating meeting the requirements of Rust-Oleum Truck Bed Coating, (ROC-149) or equal. Two coats of inhibitor from the below-ground end to 6-inch above the final ground elevation.

B. Provide HTCB end terminals that are crashworthy in accordance with the latest MASH testing requirements for a Test level 3 (TL-3) installation.

1. Galvanized steel posts Section 1070
   a. Rust inhibitor coating meeting the requirements of Rust-Oleum Truck Bed Coating, (ROC-149) or equal. Two coats of inhibitor from the below-ground end to 6-inch above the final ground elevation.

722.3 Construction.

722.3.1 Submittals.

A. Submit the following to the engineer before starting construction:

1. FHWA eligibility letters for the proposed HTCB system and end terminals.
2. Buy America certification for steel used on the Project.
3. Installation manual and HTCB system shop drawings.
4. Design details, calculations, dimensions, and specifications for line post concrete footings and concrete end-terminal anchors. Base the design of line post concrete footings and concrete end-terminal anchors on the specific project location, requirements as shown on the contract, what is specified here, and on Department supplied soil boring information.
5. Rust inhibitor specifications.

722.3.2 Training.

A. Provide on-site field instruction by the system manufacturer, at a location determined by the engineer. Provide a minimum of 2 training sessions consisting of installation training before beginning cable barrier construction and maintenance training before primary inspection. The

manufacturer shall establish the training duration and shall provide field training on all aspects of the system. Coordinate the training schedule and location with the engineer. The engineer will advise the appropriate department staff, including construction inspectors and maintenance personnel regarding the training location and schedule. Provide all training materials in both hard copy and electronic PDF format.

B. Installation Training.

1. Hold the installation training before beginning HTCB construction. Submit the proposed training date to the engineer a minimum of 14 calendar days before the session date for review and approval. At a minimum, the training shall include the following participants:
   a. The prime contractor's field superintendent, or designated representative.
   b. HTCB sub-contractor's field supervisor, or designated representative.
   c. The engineer's designated representatives including the project's construction inspectors.
2. The engineer will have final approval of participants. Provide every participant with a complete set of training 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:
   a. Description and function of all system components.
   b. Manufacturer's instructions and specifications for:
      i. End anchor and post foundation installation, including foundation sizes, steel reinforcement, concrete design strength, curing time, concrete testing, and locations;
      ii. line post installation;
      iii. end terminal assembly installation; and
      iv. wire rope installation and tensioning.
   c. Sequence of construction operations.
   d. Discussion of critical tasks.
   e. Installation inspection.

C. Maintenance Training.

1. Hold the maintenance training a minimum of 7 calendar days before primary inspection of the system. Submit the proposed training date to the engineer a minimum of 14 calendar days prior to the training session date for review and approval. Include the following participants:
   a. District Maintenance Engineer, or designated representative;
   b. District Maintenance Superintendent, or designated representative;
   c. Area Yard Supervisor, or designated representative; and
   d. District maintenance personnel.
2. The engineer will have final approval of participants. Provide every participant with a complete set of training 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:

a. A description of the system components.

b. A discussion of critical features.

c. Cable barrier and terminal assembly inspection.

d. Cable barrier component replacement.

e. Terminal assembly replacement.

f. Cable tension monitoring and re-tensioning.

g. End anchor reattachment.

h. Freeing captured vehicles.

i. Field cable splicing.

722.3.3 Construction.

A. Provide construction stake-out for the line posts and end terminals. Notify the engineer of any potential conflicts with underground utilities or drainage before 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 with the proposed alignment of the high-tension cable barrier system.

B. Complete all clearing, grubbing, and final grading before installing each section of cable barrier post foundations, terminals, transitions, or anchor systems. Excavate and grade as necessary for the HTCB maintenance strip in accordance with the contract. Pave the maintenance strip before excavating and drilling post foundations.

C. Excavate and install cast-in-place, reinforced concrete foundations for line posts and end terminal foundations in accordance with the manufacturer's requirements and approved foundation shop drawings. Place foundation reinforcing steel as required in the approved shop drawings. Place the concrete and install sockets, keeping the top of the foundation flush with the final grade. Place line posts and fitting gaskets. Space the posts, in accordance with the manufacturer's requirements. Set posts plumb and in a straight line.

1. Refresh any damaged rust inhibiter coatings so no metal is exposed, to the satisfaction of the engineer.

D. Install the HTCB system cables in accordance with the manufacturer's details and specifications. Position rigging screws to avoid interference with posts or other rigging screws unless recommended by the manufacturer.

E. Tension cables 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. The Department will only accept results from 1 model of tension testing device. Provide a certificate to the engineer showing that the tensioning instrument was calibrated no more than 30 calendar days before its first use on the project.

F. Provide a certified tester to perform system tension tests. Provide a letter from the manufacturer certifying that the tester is trained in the use of the testing equipment.

G. Retest the cable tension in accordance with the manufacturer's specifications 14 calendar days to 21 calendar days after the first test. Re-tension the cable when the test reading is less than the

manufacturer's recommendations for the given temperature. Re-tension the cables to the manufacturer's specifications by successively reading tension measurements at every rigging screw or turnbuckle. Repeat the testing and re-tension the cable in accordance with the manufacturer's specifications until the manufacturer certifies the full cable system.

H. Keep a tension log showing:

1. The project name;
2. date;
3. time;
4. location;
5. weather conditions;
6. ambient temperature;
7. cable temperature;
8. tension measurement location;
9. actual tension reading;
10. tension reading after adjustment; and
11. applicable notes and the signature of the person conducting the test.

I. Provide a copy of the tension log to the engineer. Provide a letter from the manufacturer certifying that the contractor tensioned the cable in accordance with the manufacturer's specifications and that the cable tension complies with the manufacturer's requirements.

J. Delineate the HTCB system 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. Ensure that delineation is 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 is 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 contractor may apply retroreflective sheeting directly to the post. On posts without flat surfaces facing approaching traffic, the contractor may apply the sheeting to the post cap.

K. Notify the engineer immediately if the traveling public damages the cable barrier during construction or prior to final acceptance of the Project. Mark the affected area as directed by the engineer within 8-hours of the damage. If only line posts incurred damage, 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, repair, re-tension, and test the system within 24-hours of contractor notification. After each hit, re-tension the system in accordance with the manufacturer's specifications, if required.

L. Within 10 calendar days of the Initial inspection, supply spare parts for the HTCB system. Deliver the parts to the DelDOT maintenance facility as directed by the engineer. Provide an extra supply of the following:

1. Socketed-type line posts, including post hardware, caps, reflective sheeting, straps, spacers, and socket covers. Include 200 posts and accessories.
2. Rigging screws and threaded terminals. Provide enough materials to complete 8 turnbuckle assemblies.
3. Anchor posts including post hardware and caps, reflective sheeting, straps, fittings, spacers, and socket covers. Provide enough materials to complete 3 end anchor installations.
4. Fitting gaskets or socket covers. Provide 100 socket covers.

M. Provide a tension meter kit and repair tool rope spreader. Provide 1 new, calibrated tension meter that bears a serial number and has a current Certificate of Calibration from a National Institute of Standards and Testing accredited laboratory.

722.4 Method of Measurement.

The Department will measure the quantity of high-tension cable barrier as the number of linear feet constructed, tested, and accepted. The Department will measure the length from the first line post adjacent to each end terminal for the run of cable barrier. The Department will not include posts associated with the end terminal, as identified in the manufacturer's shop drawings, in the linear foot quantity. The Department will measure the quantity of end terminals as the actual number of each end terminal constructed, tested and accepted.

722.5 Basis of Payment.

A. The Department will pay the quantity of high-tension cable barrier at the contract unit price per linear foot. Price and payment will constitute full compensation for:

1. Training;
2. excavation;
3. concrete and steel reinforcement;
4. backfill and backfilling;
5. providing and placing materials and components;
6. wire rope;
7. reflective sheeting;
8. testing and re-tensioning;
9. tension meter kit;
10. repair tool rope spreader; and
11. spare parts.

B. The Department will pay the quantity of end terminals at the contract unit price per each. Price and payment will constitute full compensation for:

1. Training;
2. excavation;
3. concrete and steel reinforcement;

4. backfill and backfilling;
5. providing and placing materials and components;
6. end terminals; and
7. spare end terminal posts and accessories.

ITEM	DESCRIPTION	UNIT
722001	HIGH TENSION CABLE BARRIER	LF
722002	HIGH TENSION CABLE BARRIER END TERMINAL	EACH

SECTION 723 — CONCRETE BARRIER

723.1 Description.

This work consists of constructing concrete barriers.

723.2 Materials.

A.	Borrow, Type C	Section 1001
B.	Bar Reinforcement	Section 1037
	1. Epoxy Coated	
	2. Grade 60	
C.	Expansion Joint Material	Section 1042.3.D
D.	Liquid Membrane-Forming Compounds for Curing	Section 1022
E.	PCC	Section 1022
	1. Minimum 28-day Compressive Strength - 4,500 pounds per square inch	
	2. Blend of a minimum of 40 percent Ground Granulated Blast Furnace Slag (GGBFS)	
	3. Fine Aggregate	
F.	Geotextile	Section 1060
G.	Coarse Aggregate, No. 57 Stone	Section 1004
H.	Metal Screen	Galvanized Steel
I.	Pipe for Weep Hole, PVC Schedule 40	Section 1049
J.	Silane Based Concrete Sealer	Section 1045.3

k. The Department will not allow supplier changes or substitutions once the project starts without the engineer's approval.

723.3 Construction.

A. Provide precast or cast-in place barriers meeting contract requirements. Use slip-form construction methods in accordance with the contract. Conduct a pre-pour meeting at least 10-days before the start of work with representatives from the Department, the contractor, and other involved parties.

B. Excavate and compact within the template of the barrier in accordance with Section 202 and the contract. Remove unsuitable material below the proposed foundation and replace with Borrow Type C as directed by the engineer in accordance with Section 202.

C. Construct cast-in-place barrier with forms in accordance with Section 604 and contract. Place reinforcement bars in accordance with Section 611 and contract. Construct and cure cast-in-place barrier in accordance with Section 610.3.6.

D. Construct precast units in accordance with 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 PSI. Saw cut joints to control cracking of concrete.

E. Place weep holes at 15-foot on center and in accordance with the contract. Place metal screen with openings no bigger than 1/2-inch and no smaller than 3/8-inch.

F. Apply a Class 2 rubbed finish to exposed cast-in-place or precast barrier faces in accordance with Section 610.

G. Ensure that the barrier surfaces vary no more than 1/4-inch in 10-feet as measured from a straightedge longitudinally. Meet a tolerance of 1/4-inch in vertical and horizontal alignment between adjoining units measured using a 10-foot straightedge longitudinally across the joint.

H. Construct joints in accordance with Section 610 and the Standard Construction Details.

I. Place and compact backfill of remaining excavated areas after placing the barrier. Compact the material to a minimum of 95 percent of the maximum density, in accordance with Section 202.3.9.

J. Install barrier mounted delineators on the barrier side that faces traffic. Install barrier mounted delineators as follows:

1. Place the delineator 39-inches above the final roadway surface for 42-inch or taller barriers when measured to the top of the delineator.
2. Place the delineator 29-inches above the final roadway surface for barriers less than 42-inches tall measured to the top of the delineator.
3. For tangent sections of barrier, space delineators horizontally 100 feet apart measured from the center of 1 delineator to the next reflector. For barrier sections less than 200 linear feet long, evenly space a minimum of 2 delineators on the traffic face of the barrier. For barrier sections approaching and located on horizontal curves, follow the requirements of Table 3F-1 of the DE MUTCD

K. Prepare the surface ahead of sealing in accordance with Section 613.3.B.

L. Seal surface exposed concrete barrier with a silane sealer meeting the requirements of Section 1045.3 in accordance with Section 613.3.D.

723.4 Method of Measurement.

The Department will measure the quantity of concrete barrier as the number of linear feet constructed, placed, and accepted. The Department will measure the length along the centerline of the concrete barrier.

723.5 Basis of Payment.

A. The Department will pay the quantity of concrete barrier at the contract unit price per linear foot constructed, placed, and accepted. Price and payment will constitute full compensation for:

1. Excavation within the template of the item;
2. removal and disposal of existing materials;
3. bedding and foundation preparation;
4. providing and placing materials and components;
5. compaction;
6. forms and forming;
7. supplying, placing, finishing, curing, and sealing PCC;

8. reinforcing steel;
9. joints; and
10. weep holes and metal screen.

B. The Department will pay for:

1. Undercut in accordance with Section 202;
2. PCC removal in accordance with Section 211;
3. saw cutting in accordance with Section 762;
4. GABC in accordance with Section 301;
5. bituminous pavement patching in accordance with Section 401; and
6. barrier mounted delineators in accordance with Section 824.

ITEM	DESCRIPTION	UNIT
723001	TL-3 ROADSIDE BARRIER	LF
723002	TL-4 ROADSIDE BARRIER	LF
723003	TL-5 ROADSIDE BARRIER	LF
723010	TL-3 MEDIAN BARRIER	LF
723011	TL-4 MEDIAN BARRIER	LF
723012	TL-5 MEDIAN BARRIER	LF

See Standard Construction Details for concrete barrier dimensions per Test Level (TL).

SECTION 724 — IMPACT ATTENUATOR

724.1 Description.

This work consists of providing and installing impact attenuators. Impact attenuator types are defined as follows:

A. Sacrificial – Devices designed for a single impact. These systems' major components are destroyed in impacts and must be replaced, but many of the other parts of the system can be reused.

B. Reusable – Contain some major components that may be able to survive most impacts intact and can be salvaged when the unit is being repaired.

C. Low Maintenance – Devices that either suffer very little, if any damage, upon impact and are easily pulled back into their full operating condition, or they partially rebound after an impact and may only need an inspection to ensure that no parts have been damaged, misaligned, or otherwise disabled.

724.2 Materials.

A. Submit documentation requesting approval of impact attenuators 14-days before the start of work. Submission requirements and instructions for source information are listed on DelDOT's website: https://deldot.gov/Business/prodlists/index.shtml.

B. Provide impact attenuators to the latest MASH compliance or in accordance with contract, selected from the approved products list. The list can be accessed by going to (https://www.deldot.gov/Business) and looking for the Approved Products List tab on the page.

C. Before installation, submit the choice of impact attenuator chosen for use on the project, with the manufacturer's installation instructions, to the engineer.

D. Provide an impact attenuator designed to leave no solid debris on the roadway after a head-on or side angle impact. Refer to the contract for dimensional requirements, if any.

E. Impact attenuator designs:

1. Type 1 – Test Level 2 – Sacrificial
2. Type 2 – Test Level 2 – Reusable
3. Type 3 – Test Level 2 – Low Maintenance
4. Type 4 – Test Level 3 – Sacrificial
5. Type 5 – Test Level 3 – Reusable
6. Type 6 – Test Level 3 – Low Maintenance

724.3 Construction.

A. Provide shop drawings to the engineer for approval before beginning installation. Assemble and install the impact attenuator in accordance with the manufacturer's requirements. Grade the area between the edge of pavement and the back of the impact attenuator in accordance with the manufacturer's requirements.

B. Construct guardrail end treatment using applicable construction methods provided in Section 720.3.

C. Notify the engineer and request acceptance after completing installation of the impact attenuator. The engineer will inspect the installation. The Department will assume responsibility once the engineer accepts the installation. The engineer will notify the contractor to make repairs if an impact attenuator is damaged before final project acceptance and the engineer determines that the damage was not the result of contractor negligence.

724.4 Method of Measurement.

A. The Department will measure the quantity of new impact attenuators as the number provided, assembled, installed, and accepted.

B. The Department will measure the quantity of impact attenuators replaced due to damage not caused by the contractor as the number provided, assembled, installed, and accepted.

724.5 Basis of Payment.

A. The Department will pay the quantity of new impact attenuators at the contract unit price per each. Price and payment will constitute full compensation for:

1. Pre-installation field meeting;
2. test pits;
3. providing and placing materials and components in accordance to the manufacturer's installation instructions;
4. shop drawings;
5. fabricating;
6. excavating;
7. burring of bolts;
8. backfilling;
9. grading;
10. compacting;
11. disposing of surplus materials and components; and
12. patching material around posts.

B. The Department will pay for a foundation when it is determined that the existing foundation does not meet manufacture's recommendations in accordance with the following section:

1. Excavation and backfill in accordance with Section 202;
2. Saw cutting in accordance with Section 762; and
3. Pavement patching in accordance with Sections 401 or 503.

C. The Department will pay the quantity of damaged impact attenuators replaced and disposed of at the contract unit price, if complete replacement is required, or at a negotiated price, if a partial replacement or repair is required.

ITEM	DESCRIPTION	UNIT

724001	PERMANENT IMPACT ATTENUATOR, TYPE 1	EACH
724002	PERMANENT IMPACT ATTENUATOR, TYPE 2	EACH
724003	PERMANENT IMPACT ATTENUATOR, TYPE 3	EACH
724004	PERMANENT IMPACT ATTENUATOR, TYPE 4	EACH
724005	PERMANENT IMPACT ATTENUATOR, TYPE 5	EACH
724006	PERMANENT IMPACT ATTENUATOR, TYPE 6	EACH
724008	PERMANENT IMPACT ATTENUATOR, WIDE BAY, TYPE 2	EACH
724009	PERMANENT IMPACT ATTENUATOR, WIDE BAY, TYPE 3	EACH
724010	PERMANENT IMPACT ATTENUATOR, WIDE BAY, TYPE 5	EACH
724011	PERMANENT IMPACT ATTENUATOR, WIDE BAY, TYPE 6	EACH

SECTION 727 — FENCE

727.1 Description.

This work consists of installation, repair, or relocation of fencing and gates.

727.2 Materials.

A.	PCC, Class B	Section 1022 or Section 1023
B.	Non-Shrink Grout	Section 1047.2
C.	Fence Materials	Section 1061

D. Grounding Rod

1. Underwriters Laboratories Approved.
2. 5/8-inch Nominal Diameter.
3. 8-feet long, Minimum, Unless Otherwise Specified.
4. Copper-Bonded Steel.
5. Approved Clamps for Connection the Grounding Conductor to the Ground Rod.

727.3 Construction.

727.3.1 Working Drawings.

Before fabrication, submit working drawings, in accordance with Section 105.4, for all metal structures with an open span length greater than 60-inches. Ensure that working drawings include the manufacturer's installation instructions, fence details, and calculations. Provide drawings sealed by a professional engineer registered in the State of Delaware, if required by the contract.

727.3.2 Preparation.

A. Remove obstructions to fence installation in accordance with Sections 201 or 211.

B. Grade fence line and around gate as necessary along fence line to provide proper grade and slope in accordance with the contract.

727.3.3 Footings.

A. Excavate footings shown in the contract.

B. When encountering rock within the planned concrete footing depth, drill a hole into the rock 2-inches larger than the largest dimension of the post cross-Section. Drill to the concrete footing depth specified in the contract. Grout the hole around post after setting the post.

C. Place post plumb in center of the footing.

D. Place PCC, Class B in the hole around post. Tamp or vibrate the concrete around post. Ensure that the top of the footing is finished smooth, slightly above the ground line, and sloped away from the post to prevent sitting water.

E. Do not place attachments to posts or disturb posts for 72-hours after placing the concrete footing. Use hand-mixed concrete only when approved by the engineer.

F. Place footings or supports for temporary fence in accordance with manufacturer's recommendations.

727.3.4 Chain Link Fence.

A. This section applies to both vinyl-coated and non-vinyl-coated chain link fences.

B. Place posts plumb at 10-foot centers with a tolerance of +0 and -2 feet of the contract requirements. Space posts in a uniform manner. Place posts a minimum of 30-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, not exceeding 500-feet between terminal posts.

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 manufacturer recommended heavy pressed steel connectors.

E. Place couplings every 20-feet to join top rail segments. Use couplings that allow for expansion and contraction. Obtain the engineer's approval for expansion devices.

F. Install horizontal brace rails with diagonal truss rods and turnbuckles at terminal posts. Apply sufficient braces to allow complete bracing from each terminal post to adjacent line posts. Install roll formed rail and brace 24-inches apart and tubular rail and brace 30-inches apart. Extend the rail and brace from the terminal post to the first-adjacent line post. Fasten the braces to the posts using heavy pressed steel connections and trussed from the line posts back to the terminal post with round rods as shown in the contract.

G. Equip posts with extension arms for barbed wire when required. Extend the arms at a 45-degree angle. 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. Use extension arms capable of supporting a dead load of 200-pounds at the top strand attachment point without deforming.

H. Install fence fabric on the roadway side of the posts, true to line, taut, and in accordance with the manufacturer's recommendations. Provide a separation from the fence fabric and the ground line in accordance to the Standard Construction Details. Excavate or backfill as necessary to maintain the required gap. Span the opening below the fence using wire mesh at locations where it is not practical to maintain the gap requirements, such as small drainage swales or ditches.

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.

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. Place the end connectors as close to the ends of the fabric as possible.

K. Fasten the fence fabric securely 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 weave the fabric integrally into lock loops on roll form sections.

L. When tying into an existing fence, attach the existing fence to terminal posts of the new fence where indicated in the contract.

M. Install electrical grounds at intervals of no more than 2,000-feet and directly below locations where an electrical line passes over the fence. Drive the rod vertically into the ground until the top is approximately 6-inches below the soil surface. Clamp copper conductor to the rod and to the fence to complete the ground.

1. If rock is encountered and acceptable earth grounding by driving as described above cannot be achieved, the engineer may direct use of a grounding grid. Exothermically weld direct buried rods end-to-end to bond fences in a continuous series such that an acceptable ground can be achieved.

N. When placing a coated fence, repair damaged coating in accordance with manufacturer's recommendation.

O. Gates.

1. Vehicular Gates.

a. 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. Use ball and socket type bottom hinges designed to carry the weight of the gate on the post footing. Use a wrap-around adjustable type upper hinge.

b. Equip gates with a positive-type latching device, with a provision for padlocking. Provide drive gates with a center plunger rod and catch and semi-automatic outer catches to secure the gate in the opened position. Provide vehicular gates capable of operation by 1 person that swing open 180-degrees.

c. Install the vehicular gates such that the bottom of the gates are 3-inches to 5-inches above the ground when closed and at least 3-inches above ground at all points of the gate swing.

d. Refer to the contract for additional information not included here.

2. Walking Gates.

a. Provide walking gates 4-feet wide that match the fence height.

b. Equip the walking gates with approved latches, stops, locking devices, and approved devices to allow padlocking.

c. Ensure the same ground clearance for walking gates as required for vehicular gates.

727.3.5 Bridge Safety Fence.

A. Construct bridge safety fence in accordance with Section 727.3.4 and the bridge safety fence details in the contract.

B. Make longitudinal rails parallel to the top of parapet. Set all posts normal to the top of parapet for roadway grades of 6 percent or less. For grades over 6 percent set the posts plumb.

C. Install the chain link fence true to line, taut, and in accordance with the manufacturer's recommendations. Position the parts and rails before placing fabric.

727.3.6 Right-of-Way Fence.

A. Place metal right-of-way fence posts plumb and in accordance with the Standard Construction Details.

B. Attach metal post braces to metal end posts, intermediate end posts, corner posts, and gate posts. Set metal posts and braces in concrete footings in accordance with the contract.

C. Place 2 braces on corner posts and intermediate end posts, 1 on each side of the posts in the main line of the fence.

D. Place 1 brace on end posts and gate posts in the line of the fence.

E. Brace line posts in both directions at intervals of no more than 500-feet.

F. Install fence fabric in accordance with the contract.

G. Refer to Sections 727.3.4.H through 727.3.4.K for further guidance on fence fabric installation.

H. Refer to Section 727.3.4.M. for further guidance on installing electrical grounds.

I. Refer to Section 727.3.4.O.1 for further guidance on installing vehicular gates.

J. Refer to Section 727.3.4.O.2 for further guidance on installing walking gates.

727.3.7 Post and Rail Fence.

A. Follow the manufacturer's installation instructions. Provide wood or vinyl fence material in accordance with the contract.

B. If the contract includes gates, install gates in accordance with the manufacturer's instructions.

727.3.8 Vertical Slat Fence.

A. Install the fence true to line and ensure grade and top elevation uniformity. Place the vertical boards on the roadway side of posts and backers and maintain a minimum of 1-inch and a maximum of 6-inches of separation from the vertical boards and the ground line unless otherwise shown in the contract. Install the vertical boards of the fence before cutting or shaping the top.

B. If the contract shows gates, install in accordance with the manufacturer's instructions.

727.3.9 Decorative Fence.

A. Construct the decorative fence in accordance with the contract and the manufacturer's installation instructions.

B. Center and align post base plates when the contract specifies aluminum fencing. Anchor on concrete foundations with a neoprene pad, or approved equivalent, between the aluminum base plate and concrete surface.

C. If the contract includes gates, install in accordance with the manufacturer's instructions.

727.3.10 Temporary Construction Safety Fence.

A. Space posts no more than 10-feet apart. Obtain approval from the construction safety fence manufacturer for alternate spacing.

B. Use 8-inch self-locking nylon safety ties for securing the fence to the post.

C. Install bottom rail edging for cane detection by the visually impaired between 2 1/2-inches to 6-inches above the surface of the sidewalk or pathway.

D. Relocate the safety fence as necessary to perform construction activities.

E. Remove construction safety fence and associated debris at the direction of the engineer at the end of construction activities.

F. If the contract includes gates, install in accordance with the manufacturer's instructions.

727.3.11 Repair Fences and Gates.

A. Ensure that materials and construction methods required for repairs conform to the applicable requirements for the fencing types described in Section 727.3.

B. Fence.

1. Align all posts, fabric, and other components when attaching new fence fabric to the existing fabric or posts.

2. Remove damaged fencing, trees, brush, and debris resulting from the repair work, from the job site by the end of every working day.

C. Gate.

1. Align all posts, gates, fabric and other components when repairing existing gates.

2. Refer to Section 727.3.11.B.2 for further guidance on disposal of materials.

727.3.12 Relocate Fences and Gates.

A. Fence.

1. Salvage existing fence components. Reuse salvaged fence that the engineer approves for reuse. Replace salvaged material the engineer does not approve for reuse with an approved equal. Obtaining the engineer's approval for the replacement material.

2. Notify the engineer at least 3-days in advance before removing fencing, unless otherwise specified in the contract. Remove, salvage, and reset existing fence components at the locations indicated in the contract. Backfill the holes left by post removals in accordance with Section 209.

3. Ensure that spacing and setting of the posts, railing, and fence panels matches the existing contours of the grade.

B. Gate.

1. Remove the gate from the existing location and reset at the location designated in the contract.

2. Clean the gate posts of any existing debris including existing foundation concrete. The engineer may request that the contractor supply new posts, at no additional cost to the Department, if in the opinion of the engineer the existing posts are not satisfactorily cleaned. The size, type, and length must match the existing posts. Set the posts plumb, true to the line and grade shown in the contract. Embed each gate post in a concrete footing with minimum dimensions in accordance with Section 727.3.3.

727.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Fence as the number of linear feet along the line of the fence from end to end for each type of fence placed and accepted.

2. Bridge safety fence as the number of linear feet along the line of the fence from end to end. The Department will not measure anti-climb shields or other components. The Department will include payment for these components in the linear foot cost of the bridge safety fence.
3. Gates as the number of each type of gate installed and accepted.
4. The Department will not measure fence or gate repair.
5. Relocated fence as the number of linear feet of each type of fence relocated and accepted measured along the relocated fence.
6. Relocated gates as the number of each type of gate relocated and accepted.

727.5 Basis of Payment.

A. The Department will pay the quantity of:

1. Chain link, right-of-way, and relocated fence at the contract unit price per linear foot for each type of fence. Price and payment will constitute full compensation for:
   a. Clearing and grading the fence line;
   b. excavating and backfilling footings;
   c. providing and placing footing concrete;
   d. providing and installing grounding rods and grounding grids including clamps and conductors; and
   e. providing and erecting fence.
2. Vertical slat, post and rail, decorative, temporary construction, and bridge safety fence at the contract unit price per linear foot for each type of fence. Price and payment will constitute full compensation for:
   a. Clearing and grading the fence line;
   b. excavating and backfilling footings;
   c. providing and placing footing concrete;
   d. providing and erecting fence;
   e. providing and installing anti-climb shields for bridge safety fence;
   f. removal and disposal of safety fence; and
   g. maintenance or replacement of safety fence during construction.
3. New and relocated gates at the contract unit price for each type of gate. Price and payment will constitute full compensation for:
   a. Clearing and grading the gate line;
   b. excavating and backfilling for footings;
   c. providing and placing footing concrete;
   d. providing and erecting gates; and
   e. restoring disturbed areas to the original conditions.

B. The Department will pay for repairing fence and gates at the contract lump sum price. Price and payment will constitute full compensation for:

1. Clearing and grading;
2. excavating and backfilling for footings;
3. providing and placing footing concrete;
4. removal and disposal of fencing and gate components and other debris generated by the repair work; and
5. restoring disturbed areas to the original conditions.

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
727007	BRIDGE SAFETY FENCE, TYPE 1	LF
727008	BRIDGE SAFETY FENCE, TYPE 2	LF
727010	CHAIN LINK FENCE GATE	EACH
727011	RIGHT-OF-WAY FENCE GATE	EACH
727012	TEMPORARY CONSTRCUTION SAFETY FENCE GATE	EACH
727013	DECORATIVE FENCE GATE	EACH
727030	FENCE RELOCATION	LF
727031	GATE RELOCATION	EACH
727032	FENCE REPAIR	LF
727033	GATE REPAIR	EACH

SECTION 760 — PAVEMENT MILLING AND RUMBLE STRIPS

760.1 Description.

This work consists of milling bituminous or PCC pavement and creating rumble strips.

760.2 Materials.

Not applicable.

760.3 Construction.

760.3.1 Pavement Milling.

A. Equip milling 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 of an inch at any point along the surface. Open a milled surface to traffic only after removing all loose material. Provide temporary bituminous concrete wedges at any grade change of 2 inches or greater in accordance with the DE MUTCD.

B. Taper cuts consist of one pass between 6- feet and 8-feet with a specified depth at one edge and zero depth at the other edge.

760.3.2 Rumble Strips.

A. Cut the rumble strips to dimensions in accordance with the contract or in accordance with the Standard Construction Details without tearing or snagging.

B. Remove and dispose of millings.

760.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Pavement milling as the number of square yards per inch of depth. The Department will not measure additional depth that the engineer did not provide written approval for milling.
2. Taper cut in square yards per inch.
3. Rumble strips longitudinally as the number of linear feet installed and accepted. The Department will not measure the 12-foot openings in bike-friendly rumble strips.

760.5 Basis of Payment.

A. The Department will pay for pavement milling at the contract unit price per square yard per inch. Price and payment will constitute full compensation for:

1. Pavement milling or planing;
2. cleanup of the bituminous concrete or PCC pavement residue wedge left from the milling operation along the curb line, adjacent to speed humps, across intersecting streets, around manholes, and at the beginning and ending points of the milling operation; and
3. removing and disposing of milled material.

B. The Department will pay for rumble strips at the contract unit price per linear foot and accepted in-place. Price and payment will constitute full compensation for:

1. Pavement milling or planing; and
2. removing and disposing of milled material.

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, PCC PAVEMENT	SY-IN

SECTION 762 — SAW CUTTING AND BUTT JOINTS

762.1 Description.

This work consists of mechanically saw cutting and butt joints to join new and existing pavements.

762.2 Materials.

None.

762.3 Construction.

A. Use a walk behind, motor driven, wet type diamond blade, circular cutter with control devices, mounted on a sturdy frame designed to cut PCC and bituminous concrete pavements. Supply water continuously to the cutting blade either by water tank on the equipment or by other means. Cut a groove in a straight line deep enough to allow for removal of material without damaging the adjacent pavement.

B. The contractor may use other equipment for saw cutting non pavement items.

C. Construct butt joints in accordance with Section 760.3.1.

D. Remove waste material created in accordance with Sections 106.8 and 903.3. Seal saw cuts made beyond the limits defined in the contract with an approved sealant.

762.4 Method of Measurement.

A. The Department will measure the quantity of saw cutting PCC and bituminous concrete as the number of linear feet of pavement, saw cut and accepted, along the cut end to end.

B. Composite pavement of asphalt over concrete is to be measured as sawcutting concrete.

C. Should composite pavement of asphalt over concrete exceed 18-inches in depth, the Department will measure the quantity of a second saw cut as the number of linear feet of pavement, saw cut and accepted, measured along the second saw cut end to end.

D. The Department will not measure:

1. Overcuts;
2. additional saw cuts resulting from damage caused during patch removal;
3. relief cuts to assist in pavement removal; and
4. transverse saw cuts for crack control in Type B patches except for the two end joints at the patch perimeter.

E. The Department will measure the quantity of butt joints as the number of square yards on the surface of the pavement in accordance with the contract.

762.5 Basis of Payment.

A. The Department will pay the quantity of saw cutting PCC and bituminous concrete at the contract unit price per linear foot. Price and payment will constitute full compensation for:

1. Saw cutting PCC and bituminous concrete;
2. disposing of waste material; and

3. sealing overcuts in accordance with Section 504.3.

B. The Department will pay the quantity of butt joints at the contract unit price per square yard. Price and payment will constitute full compensation for:

1. Saw cutting;
2. pavement milling or planning;
3. removing disposing of existing pavement; and
4. sealing overcuts in accordance with Section 504.3.

ITEM	DESCRIPTION	UNIT
762000	SAWCUTTING, BITUMINOUS CONCRETE	LF
762001	SAWCUTTING, CONCRETE, FULL DEPTH	LF
762002	SAWCUTTING, CONCRETE, VARIABLE DEPTH	LF
762003	SAWCUTTING, GREATER THAN 18” IN DEPTH	LF
762004	BUTT JOINTS	SY

SECTION 763 — INITIAL EXPENSE, DE-MOBILIZATION

763.1 Description.

This work consists of mobilization and de-mobilization.

763.2 Materials.

Assume responsibility for the adequacy of all materials not required by the contract needed to assemble and set up the project.

763.3 Construction.

A. Perform operations necessary for assembling and setting up of the project, including:

1. The initial movement of personnel and equipment to the project site;
2. establishing the contractor's offices, shops, plants, storage areas, and sanitary facilities;
3. other activities required by the contract and by law or regulation;
4. other work and operations required before beginning compensable items of work; and
5. obtaining the required insurance, bonds, and all other items required for the start of work.

B. Perform operations necessary for final jobsite cleanup including:

1. De-mobilization of personnel and equipment; and
2. Submitting all project closeout paperwork including subcontractor releases.

C. Develop progress schedules and updates in accordance with Section 108.4.

763.4 Method of Measurement.

The Department will not measure the work in this section.

763.5 Basis of Payment.

A. The Department will pay the lump sum unit bid price for this work. Price and payment constitute full compensation for work associated with mobilizing and demobilizing the project.

B. 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"), the Department will pay 45 percent of the item on each of the first 2 monthly estimates and the last 10 percent of the item on the final estimate. When the lump sum price for this item exceeds 5 percent of the total bid price, the Department will pay 2.25 percent of the total bid price on each of the first 2 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.

C. Payment of the contract lump sum price for initial expense, demobilization will not be made more than once, regardless of the number of times that the contractor must mobilize or demobilize from the site.

D. The Department will pay for provide progress schedules and updates in accordance with Section 108.4.

ITEM	DESCRIPTION	UNIT

763000	INITIAL EXPENSE / DEMOBILIZATION	LS

DIVISION 800 — TRAFFIC

SECTION 801 — TEMPORARY TRAFFIC CONTROL — GENERAL

801.1 Description.

This work consists of providing temporary traffic control to maintain vehicular, bicycle, and pedestrian traffic through the project work zone. Temporary traffic control device categories are defined by type, such as:

A. Category I – Devices including traffic cones, plastic traffic drums, portable delineators, and channelizers.

B. Category II – Devices include barricades and portable sign supports.

C. Category III – Devices include crash cushions, truck mounted attenuators, temporary railing, temporary barrier, and end treatments for temporary railings and barriers.

801.2 Materials.

A. Crashworthy temporary traffic control devices per the DelDOT Temporary Traffic Control Approved Product List: https://deldot.gov/Business/prodlists/pdfs/APL_TTCDevices.pdf

B. Category I through Category III temporary traffic control devices, in accordance with MASH – Certification of compliance with MASH is required.

1. Category I devices – The manufacturer or contractor may self-certify that the devices meet the MASH criteria.

2. Category II and III devices – Provide devices selected from the Approved Products List and MASH eligibility letter, including all applicable attachments required for each type of device.

C. Submit documentation requesting approval of temporary traffic control devices 14-days before the start of work. Submission requirements and instructions for source information are listed on DelDOT's website: https://deldot.gov/Business/prodlists/index.shtml. The Department approves temporary traffic control devices based on:

1. Self-Certification

2. Approved products lists

801.3 Construction.

A. Place temporary traffic control devices in accordance with the contract and DE MUTCD. Follow the manufacturer's installation instructions.

B. Maintain temporary traffic control devices throughout the project duration. Replace damaged temporary traffic control devices within 24-hours of notification or when directed by the engineer.

C. Maintain temporary traffic control devices at a minimum in 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 may reject a temporary traffic control device that does not meet the "marginal" condition.

D. Temporary traffic control devices are the contractor's property unless otherwise indicated in the contract.

E. Provide ATSSA traffic control supervisor in accordance with the contract.

801.3.1 General Temporary Traffic Control and Traffic Maintenance.

A. Maintain a work zone that protects the travelling public and persons working on the project. If necessary, implement additional safety measures not expressly required by the contract to ensure the safety of all persons.

1. The contractor may adjust longitudinal dimensions for maintenance of traffic configurations to fit field conditions.

C. Inventory existing signs within the contract limits.

1. Maintain existing signs that must remain in place during the project as noted in the contract or as directed by the engineer.

2. Remove other existing signs and store.

D. Always maintain access within the project limits.

1. Businesses and Residences.

a. Coordinate temporary driveway or entrance closures for tie-in purposes with the engineer and the property owner in advance of the closures.

2. Regarding bus stops, unless otherwise directed by the contract or the engineer:

a. Maintain an area for the bus vehicle to safely pick-up and drop-off passengers.

b. Provide an accessible path for pedestrians to safely access the bus stop.

3. Regarding bicycles and pedestrians:

a. Maintain existing access.

E. Conduct construction operations in a manner that minimizes delays to traffic.

1. Follow the requirements of the memorandum titled, "Temporary Traffic Control within Intersections," of the DE MUTCD for work within intersections or in close proximity to intersections.

2. Schedule work in the vicinity of traffic signals to minimize the time during which the signal operates without detection.

3. Set temporary traffic control devices on the work zone side of the pavement marking, if possible, when closing a lane adjacent to an open lane.

4. Do not close lanes unless a construction activity requiring a lane closure is taking place or will take place within 1-hour of closure, except for buffer lanes on high volume or high-speed roadways. Reopen lanes immediately upon completing 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 minimizes disruption to traffic during peak hours and periods of heavy traffic flow. The Department will stop the contractor's operations if, in the opinion of the engineer, such operations are unnecessarily impeding traffic.

801.3.2 Notifications to the Engineer.

A. Notification to the engineer for road closures and detours.

1. Submit notification no less than 14 calendar days before the start of detours and road closures.
2. Obtain the approval of the chief traffic engineer, or designee, a minimum of 48 hours in advance of proposed restrictions beyond those specified in the contract.

B. Loop detectors at signalized intersections.

1. Submit a schedule 7 calendar days in advance of the proposed start date of work. Obtain engineer approval before the start of work.
2. Notify the Transportation Management Center (TMC) 48-hours in advance of cutting a loop detector and immediately notify the TMC after reinstalling the loop detector.

C. Written notice to property owners, businesses, and residents.

1. Provide written notice 48-hours in advance of the start of construction work including the following:
   a. The scope of work, working hours, anticipated start and completion dates, and a summary of construction activities that might interfere with property access.
   b. A schedule and access coordination plan.
   c. The contractor's name, address, and a Department contact phone number.

D. Provide written verification to the engineer that the property owners and residents were notified.

E. Failure to give proper notice may result in suspension of work in accordance with Section 104.2.D.

F. Before obstructing a fire hydrant, notify the local 911 center and provide the engineer with written confirmation of the notice.

801.3.3 Pavement Edge Drop-offs and Vertical Differences.

A. At the end of each workday, correct all pavement edge drop-offs and vertical differences, in accordance with the DE MUTCD.

1. Use TRM to accomplish this work unless the contract specifies an alternate method. Place TRM in accordance with the applicable sections of this specification.

B. When temporary elimination of a drop-off hazard is not possible, follow the requirements of Section 6G.20 of the DE MUTCD. Mark and protect the drop-off hazard with temporary barriers, barricades, or warning signs.

C. Use steel plates to cover unprotected open trench areas accessible by vehicular traffic within the clear zone that will not receive backfill material before the end of the day.

1. Provide and install steel plates in accordance with the Standard Construction Details.
2. Submit steel plate shop drawings prepared and signed by a professional engineer registered in the State of Delaware when using steel plates larger than those specified in the Standard Construction Details. Obtain approval before starting construction. Ensure that the shop drawings:
   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 plate movement.

c. The Department will not allow use of steel plates between November 1 and March 31, without the engineer's approval.

801.3.4 Temporary Pavement Markings.

A. Apply temporary pavement markings at the end of each day's operation to all locations that require permanent pavement markings before returning traffic to unrestricted roadway use.

B. Match temporary pavement markings to the permanent pavement markings shown in the contract or as directed by the engineer.

1. Maintain retroreflectivity levels in accordance with the applicable temporary pavement marking Section.

2. Refresh temporary pavement markings as required or as directed by the engineer.

3. Apply temporary pavement markings in accordance with the applicable temporary pavement marking Section, the DE MUTCD, and DelDOT's Temporary Pavement Markings Policy of the DE MUTCD, when the contract does not provide a layout for temporary markings.

C. Remove conflicting pavement markings as directed by the engineer in accordance with Section 868. The Department will not allow painting over the conflicting pavement markings unless specifically allowed by the contract.

D. When the contract does not provide existing pavement marking information, before beginning construction, submit detailed drawings showing the existing elements for each project location. Include lane and shoulder widths, turn lane lengths, locations of stop bars, turn arrows, crosswalks, and railroad crossings in the drawings.

E. The engineer may require changes to the final pavement markings.

801.3.5 Travel Lane and Road Closure Restrictions.

A. The Department will not allow travel lane, turn lane, ramp, or road closures on interstates, freeways, expressways, or principal arterials during the following holidays, unless otherwise noted in the contract:

1. Christmas Day

2. New Year's Day

3. Memorial Day

4. Independence Day

5. Labor Day

6 Thanksgiving Day

7. Special Events

B. Keep lanes open for a period of time that depends on the day of the week that the legal or observed holiday falls. The following schedule determines the periods of time the lanes must remain open, unless otherwise allowed by the contract:

Table 801.3-1. Holiday Lane Closure Restrictions by Day of the Week

Day of Holiday or Event	Time All Lanes Must be Open to Traffic
Sunday	12:00 PM Friday through 5:59 AM Monday
Monday	12:00 PM Friday through 11:59 PM Monday
Tuesday	12:00 PM Monday through 11:59 PM Tuesday
Wednesday	12:00 PM Tuesday through 11:59 PM Wednesday
Thursday	12:00 PM Wednesday through 11:59 PM Thursday
Thursday (Thanksgiving)	6:00 AM Wednesday through 11:59 PM Sunday
Friday	12:00 PM Thursday through 5:59 AM Monday
Saturday	12:00 PM Friday through 5:59 AM Monday

C. Do not close travel lanes, ramps, or roads within 1-mile of a designated polling place during the primary and general elections that fall during an even numbered year.

D. Follow all additional restrictions that may apply as noted in the contract or as directed by the engineer.

801.3.6 Non-Compliance.

A. The Department will consider failure to comply with the requirements of this section as justification for suspension of work in accordance with Section 104.2.D. The Department will continue assessing time charges until the contractor corrects the deficiencies.

B. Non-compliance includes:

1. Failure to correct deficiencies within 24-hours of written deficiency notices related to temporary traffic control.
2. Non-compliance with the DE MUTCD or the contract.
3. Unsafe operations.
4. Placement of non-compliant temporary traffic control devices.

801.4 Method of Measurement.

The Department will not measure this item.

801.5 Basis of Payment.

A. The Department will pay for temporary traffic control at the lump sum contract price. Price and payment will constitute full compensation for:

1. Maintenance of traffic activities accepted by the engineer;
2. submitting TTCPs;
3. submitting certifications;
4. use of traffic cones;
5. correcting edge drop-offs; and
6. a certified ATSSA traffic control supervisor.

B. The Department will consider the cost to move temporary traffic control devices in accordance with the TTCPs or as necessary to address safety issues as included in this item.

C. If the contractor does not complete the contract work within the allowable contract time, including approved time extensions, the Department will hold the contractor responsible for providing and maintaining the necessary temporary traffic control devices required to complete remaining work. The Department will not pay for providing or maintaining traffic control beyond expiration of the contract time.

D. The Department will consider the cost of providing and placing steel plates as incidental to the construction item.

E. The Department will pay for:

1. Placement of temporary pavement markings with other items on the Contract.

2. Placement of temporary warning signs in accordance with Section 810.

3. Providing and placing TRM in accordance with Section 403.

ITEM	DESCRIPTION	UNIT
801000	MAINTENANCE OF TRAFFIC	LS

SECTION 802 — ARROW BOARDS

802.1 Description.

This work consists of providing, placing, relocating, and maintenance of portable arrow boards.

802.2 Materials.

Not applicable**.**

802.3 Construction.

Use and place arrow boards in accordance with the applicable sections of the DE MUTCD. Provide a trailer in accordance with Title 21 Motor Vehicles of the Delaware Code. Maintain arrow boards in good working order so that the arrow board meets, at a minimum, the "marginal" criteria of the brochure entitled "Quality Guidelines for Temporary Traffic Control Devices" in accordance with Section 801.3. Remove arrow boards from the roadway when not in use. Do not store arrow boards along the shoulder or adjacent to the edge of the roadway within the clear zone.

802.3.1 Equipment.

Provide solar powered arrow boards with a double pointed arrow configuration capable of displaying a left arrow, a right arrow, a double arrow, or a 4-corner caution mode. Do not display a sequential chevron. Equip the back panel of arrow boards with 3 indicator lamps indicating the proper functioning of the board. Provide arrow board types as indicated in the table below:

Table 802.3-1. Arrow Board Minimum Size by Type

Arrow Board Type	Minimum Size
A	48 x 24 inches
B	60 x 30 inches
C	96 x 48 inches

802.4 Method of Measurement.

The Department will measure arrow boards as the number of arrow boards used each day. A day consists of any approved usage within 24-hours of placing the device. The Department will measure each arrow board only once per 24-hour period, regardless of how many times the contractor relocates the arrow board within the same project. When the contractor uses an arrow board for part of a day, the Department will measure it as 1 each day.

802.5 Basis of Payment.

A. Price and payment constitute full compensation for providing, 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.

B. The Department will pay for accepted quantities at the contract unit price.

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

803.1 Description.

This work consists of providing, placing, operating, relocating, and maintaining portable changeable message signs (PCMS).

803.2 Materials.

Not applicable**.**

803.3 Construction.

803.3.1 Equipment.

A. Provide PCMSs meeting the requirements of the DE MUTCD, consisting of like-new, corrosion resistant materials and having the following:

1. Trailer – in accordance with Title 21 Motor Vehicles of the Delaware Code.
2. Sign panel – not to exceed 144 inches in length and 90 inches in height.
3. Sighting device for determining proper alignment for maximum visibility.
4. Display capable of:
   a. Displaying 3 lines of text.
   b. Constructing each line of text using either a discrete matrix or a full matrix display.
   c. Displaying each character using a 5 x 7 array with at least 8 array modules per line, if using a discrete matrix.
   d. Providing a 4 1/4- inch to 7-inch space between each display line with no glare reflection.
   e. Displaying 8 characters per line.
   f. A character height as required by the DE MUTCD.
   g. LED illumination.

B. Provide plastic drums, in accordance with Section 805, to channelize traffic away from the PCMS unless placing the PCMS behind guardrail, barrier, or other means of positive protection. Place plastic drums in accordance with the DE MUTCD.

C. Meet the necessary requirements of the NFPA, UL, and NEC.

D. 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 cyclists. 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.

803.3.2 Operating Requirements.

A. Ensure that sign message visibility and legibility conform to the distance requirements in accordance with the DE MUTCD. Align the PCMS toward oncoming traffic with the sighting device to provide alignment for maximum visibility.

B. Use PCMS units in accordance with the DE MUTCD. Place PCMS units at the locations shown in the contract or as directed by the engineer. Obtain approval from the engineer before placement of

the PCMS. Submit a PCMS Approval Form to the engineer for review and approval of messages and the PCMS location, if the contract does not contain approved messages or locations,

C. Repair or replace PCMS within 24-hours or less after receiving notification of an operational problem. Failure to correct the problem within the 24-hours will result in no payment for the day the unit is not operating. Failure to correct the problem may also result in delay of work activities.

803.4 Method of Measurement.

A. The Department will measure PCMS units as the number used per day.

803.5 Basis of Payment.

A. The Department will pay for provide and maintain portable changeable message sign at the contract unit price per each day. Price and payment constitute full compensation for:

1. Providing, placing, operating, maintaining, relocating and removing PCMS units; and
2. providing, placing, maintaining, relocating, and removing plastic drums required for channelization around the PCMS.

B. The Department will make no additional payment for ballast used on plastic drums.

C. The Department will not measure or pay for ineffective drums not immediately replaced.

ITEM	DESCRIPTION	UNIT
803001	PROVIDE AND MAINTAIN PORTABLE CHANGEABLE MESSAGE SIGN	EA-DY

SECTION 804 — PORTABLE LIGHT ASSEMBLY

804.1 Description.

This work consists of providing, placing, operating, relocating, and maintaining portable light assemblies.

804.2 Materials.

Not applicable**.**

804.3 Construction.

A. Provide a portable light assembly unit that includes:

1. Four 1,000-watt lights
2. A fully self-contained power source mounted to a trailer
3. Equipment to allow towing by a full-size pick-up truck
4. Full compliance with Title 21 Motor Vehicles of the Delaware Code.

B. Provide plastic drums, in accordance with Section 805, to channelize traffic away from the portable light assembly except when placing the portable light assembly behind guardrail, barrier, or other means of positive protection. Place plastic drums in accordance with the DE MUTCD.

804.3.1 Operational Requirements.

A. Place the portable light assembly at locations shown in the contract or in accordance with the DE MUTCD. Position the portable light assembly so that it does not shine light directly at oncoming traffic. Extend the light assembly vertically to the unit's fullest extent and direct the lights downwards toward the work area but not exceeding more than 60-degrees measured off of the ground to prevent glare. Use channelization devices in accordance with the DE MUTCD to delineate the portable light assembly.

B. Repair or replace portable light assembly units, within 30-minutes or less, after receiving notification of an operational problem. Failure to correct the problem within the required timeframe will result in no payment for the day that the unit did not work.

C. Designate the ATSSA traffic control supervisor as the Department's contact person on all issues related to the portable light assembly. Provide an ATSSA traffic control supervisor in accordance with Section 812. If the contract does not require an ATSSA traffic control supervisor, the contractor may use a superintendent or other designee as the on-site representative. When a portable light assembly used to illuminate a flagger station fails to work, remove the flagger from the roadway. Restore the roadway to normal operations until a working portable light assembly is provided and placed unless opening the roadway to normal operations presents a safety hazard to motorists.

804.4 Method of Measurement.

A. The Department will measure portable light assembly units as the number of units used each calendar day.

804.5 Basis of Payment.

A. The Department will pay for providing and maintaining portable light assemblies at the contract unit price per each day. Price and payment constitute full compensation for providing, placing, operating, maintaining, fueling, and relocating portable light assembly units.

B. The Department will pay for plastic drums required for channelization around the portable light assemblies with Section 805.

ITEM	DESCRIPTION	UNIT
804001	PROVIDE AND MAINTAIN PORTABLE LIGHT ASSEMBLY (FLOOD LIGHTS)	EA-DY

SECTION 805 — PLASTIC TRAFFIC CONTROL DRUMS

805.1 Description.

This work consists of providing, placing, operating, relocating, and maintaining plastic traffic control drums.

805.2 Materials.

A. Provide plastic drums in accordance with the DE MUTCD and as follows:

1. Made of low-density polyethylene plastic with closed tops to prevent collection of debris.
2. With holes no more than 1/2-inch in diameter to make the drums less susceptible to wind.
3. Equipped with an approved integral device able to withstand 60 mile-per-hour winds.
4. With minimum dimensions of 18-inches in diameter at the top and bottom and 36-inches tall.
5. New or used meeting the requirements of the "Quality Guidelines for Temporary Traffic Control Devices" as defined in Section 801.
6. Equipped with a minimum of 2 fluorescent orange prismatic retroreflective stripes and 2 white prismatic retroreflective stripes, with fluorescent orange top stripe.
7. Meeting the applicable reflectivity requirements shown in the DE MUTCD.

B. Retroreflective sheeting for plastic drums in accordance with ASTM D4956, Type V that:

1. Includes alternating horizontal circumferential fluorescent orange and white prismatic retroreflective stripes, 4-inches to 6-inches wide.
2. Displays under both daylight and nighttime conditions.
3. Does not exceed 3-inches between the horizontal fluorescent orange and white stripes.

805.3 Construction.

A. Supply the plastic drum manufacturer certification to the engineer in accordance with Section 801.2.

B. Place drums in accordance with the contract and the DE MUTCD.

C. Relocate drums in accordance with the contract and the DE MUTCD.

D. Do not weight drums with sandbags. The engineer may require additional ballast weight on high speed roadways or areas susceptible to high winds.

E. Replace or immediately clean any damaged, dirty, or ineffective drums that do not meet the requirements of Section 805.2.

F. The engineer may reject unsuitable plastic drums and will notify the contractor of the drum locations.

805.4 Method of Measurement.

A. The Department will measure plastic drums as the number of plastic drums provided, installed, and maintained each workday.

805.5 Basis of Payment.

A. The Department will pay for plastic traffic control drums at the contract unit price per each day. Price and payment constitute full compensation for providing, placing, maintaining, relocating, and removing plastic drums.

B. The Department will make no additional payment for additional ballast used on plastic drums.

C. The Department will not measure or pay for ineffective drums not immediately replaced.

ITEM	DESCRIPTION	UNIT
805001	PLASTIC TRAFFIC CONTROL DRUMS	EA-DY

SECTION 806 — TRAFFIC OFFICERS

806.1 Description.

This work consists of providing traffic officers.

806.2 Materials.

Not applicable**.**

806.3 Construction.

A. Use traffic officers in a highway work zone in accordance with the latest version of the Department's Guidelines for the Use of Uniformed Law Enforcement Officers in Work Zones of the DE MUTCD.

B. Find the project specific requirements for use of traffic officers in the maintenance of traffic notes contained in the contract.

C. Ensure that traffic officers wear police officer uniforms.

D. Ensure that traffic officers wear high-visibility safety apparel when outside of a vehicle in accordance with the DE MUTCD.

E. The engineer may authorize use of additional officers for speed enforcement.

F. Mark vehicles as police vehicles and equip with:

1. Full external light bar clearly visible for 360-degrees around the vehicle and at a distance of no less than 3,000-feet under clear weather at night;
2. A radar unit or any other speed-measuring device; and
3. Two-way radios.

G. The contractor may use town police, municipal police, county police, or Delaware state police for traffic officers in accordance with the jurisdictional location of the project. The Delaware state police will make the determination regarding which police agency has jurisdiction, if questions of jurisdiction arise.

H. Obtain the engineer's approval of the schedule of hours and of the number of traffic officers anticipated for each site or operation. Submit requests for traffic officers and anticipated work schedules on a weekly basis to the police agency having jurisdiction. The police agency having jurisdiction will decide the submittal schedule.

I. Explain to the traffic officer what project activities will require the officer's services and the officer's duties while on the project. Have the engineer or the engineer's designee present to witness the contractor's explanation of the traffic officer's duties to the police officer and provide the documentation that the traffic officer is responsible for completing.

J. Do not use traffic officers to close lanes without additional temporary traffic control, except in emergencies.

K. The contractor may commence operations if the required number of traffic officers are not available, if approved by the engineer.

806.4 Method of Measurement.

The Department will measure this item as the number of hours the contractor used the traffic officers.

806.5 Basis of Payment

A. The Department will pay for traffic officers at the contract unit price per hour. Price and payment constitute full compensation for providing traffic officers, vehicles, and equipment.

B. For bidding purposes, the Department has fixed the unit price at $110.00 per hour. The Department will pay for traffic officers based on a submitted invoice from the police department plus 10 percent.

ITEM	DESCRIPTION	UNIT
806001	TRAFFIC OFFICERS	HR

SECTION 807 — TEMPORARY SAFETY BARRIER

807.1 Description.

This work consists of providing, placing, operating, relocating, and maintaining temporary safety barrier.

807.2 Materials.

807.2.1 Temporary PCC Safety Barrier.

A. Crashworthy Temporary PCC Safety Barrier crash tested under the most recent provisions of MASH, in accordance with the contract.

B. Eligibility letters in accordance with Section 801.2.

C. Segments of barrier with a stamp molded into the top indicating the barrier is in compliance with MASH. For barrier segments with no molded stamp, submit certification to the engineer of the barrier crash test in accordance with MASH and certification that the barrier meets Test Level 3 criteria.

D. Unpinned barrier systems with tested dynamic deflections of no more than 4 feet.

E. Pinned barrier systems with tested dynamic deflections of no more than:

1. 10-inches when pinned in a bituminous asphalt surface; and
2. 6-inches when pinned in concrete.

F. Pavement Hole Filler Section 1024.8

807.2.2 Reflector Panels.

A. Reflector panels in accordance with the DE MUTCD.

B. Sign material made from 0.080-gauge aluminum.

C. Fluorescent orange prismatic retroreflective sheeting on both sides of aluminum.

807.2.3 Glare Screen.

A. Glare screen as required by the contract.

B. Galvanized hardware in accordance with manufacturer's recommendations.

807.3 Construction.

807.3.1 Temporary PCC Safety Barrier.

A. Arrange pre-inspection of barrier segments with the engineer before transporting temporary PCC safety barrier to the job site.

B. Paint the traffic side of the barrier with a white latex paint before placement.

1. Temporary PCC safety barrier manufactured with white cement may be used to eliminate the need for painting the barrier, at the discretion of the engineer.

C. Place unpinned barrier as follows:

1. Place continuous unpinned barrier system at the locations shown in the contract or as directed by the engineer. Differing unpinned barrier systems are to be overlapped, in the direction of travel, by the length of two barrier sections.
2. Place unpinned barrier starting at the impact attenuator and working in the direction of traffic flow.
3. Connect unpinned barrier segments using approved joint connections.
4. Use 1 type of joint system for a single run of unpinned barrier system.

D. Install pinned barrier as follows:

1. Ensure that holes for pin installations are integral to the barrier segment.
2. Do not use metal straps pinned to the toe of the barrier and the pavement unless these are a part of the crash tested system.
3. Install continuous pinned barrier system at the locations depicted in the contract or as directed by the engineer. Differing pinned barrier systems are to be overlapped, in the direction of travel, by the length of two barrier sections.
4. Install pinned barrier starting at the impact attenuator and working in the direction of traffic flow.
5. Connect barrier segments using approved joint connections.
6. Use 1 type of joint system for a single run of pinned barrier system.
7. Install on bituminous and concrete surfaces by driving pins at the locations specified by the manufacturer and using manufacturer-supplied pins in accordance with manufacturer's requirements.

E. Remove unpinned barrier by starting at the end of the barrier run and proceeding toward the impact attenuator.

F. Remove pinned barrier as follows:

1. Begin removal starting at the end of the barrier run and proceeding toward the impact attenuator.
2. Cut flush pins that are bonded to the subgrade. Remove all other pins and fill the pavement holes created by pinning with approved pavement hole filler material.
3. Pinned barrier may only be provided, where unpinned barrier would otherwise be acceptable, if the project is overlaying the barrier area after it is removed.

G. Relocate temporary PCC safety barrier as follows:

1. Relocate existing runs of temporary PCC safety barrier to the locations shown in the contract or as directed by the engineer.
2. Remove existing runs of temporary PCC safety barrier in accordance with Sections 807.3.1.E. or 807.3.1.F.
3. Install barrier at the new location in accordance with Sections 807.3.1.C. or 807.3.1.D., as applicable.

H. Maintain temporary PCC safety barrier as follows:

1. Replace barrier segments not meeting the "marginal" criteria of the Quality Guidelines for Temporary Traffic Control Devices, in accordance with Section 801.3.

2. Do not repair cracks or spalls in temporary PCC safety barrier.
3. Examples of unacceptable barrier condition are when:
   a. The barrier has multiple cracks throughout, structural cracks, or cracks through the entire cross-section.
   b. The barrier has spalls with a depth greater than 1 1/2-inches.
   c. There is exposed rebar or rebar is protruding from the barrier, not including anchor slots.
   d. Bolts are protruding from the barrier face.
4. Replace damaged barrier segments within 24-hours of damage notification.
5. Straighten sections of un-damaged barrier wall that deflected due to a crash within 24-hours of deflection notification.
6. Repaint the traffic side of temporary PCC safety barrier a minimum of once a year or http://www.atssa.com/ as directed by the engineer.
7. Clean temporary PCC safety barrier once every 3-months while in place on the roadway unless otherwise directed by DelDOT Traffic. During winter months, clean the barrier in a manner that does not create ice on the roadway.

807.3.2 Reflector Panels.

A. For all types of temporary PCC safety barrier:
   1. Install reflector panels on the top of the concrete barrier using bolts, epoxy, or approved adhesive after placing barriers.
   2. Install reflector panels at the intervals required by the DE MUTCD.
   3. Replace damaged reflector panels, or those reflector panels not meeting at least the “marginal” criteria of the Quality Guidelines for Temporary Traffic Control Devices, upon completion of barrier relocation within 24-hours of notification.
   4. Remove reflector panels before removing temporary PCC safety barrier in a manner that does not damage the barrier.
   5. Replace damaged reflector panels or those reflector panels not meeting at least the “marginal” criteria of the Quality Guidelines for Temporary Traffic Control Devices within 24 hours of notification.

807.3.3 Glare Screen.

A. Provide and install a glare screen system on top of temporary PCC safety barrier if required by the contract or directed by the engineer.
B. Submit shop drawings for the proposed glare screen system showing the recommended installation spacing, angle, height, and all materials for approval by the engineer.
C. Install the glare screen system in accordance with the manufacturer’s recommendations and the details shown on the approved shop drawings.
D. Repair damaged sections of glare screen within 24-hours of notification.
E. Remove glare screen from the barrier wall when no longer required in a manner that does not damage the barrier.

807.4 Method of Measurement.

A. The Department will measure:

1. Temporary PCC safety barrier as the number of linear feet along the centerline of barrier in place, provided and installed or relocated.
2. Installation and removal of pins as the number of linear feet along the centerline of barrier of pins installed or removed.
3. Glare screen as the number of linear feet along the line of the screen from center to center of the end section, provided, installed, and accepted.

807.5 Basis of Payment.

A. The Department will pay the accepted quantities of temporary PCC safety barrier at the contract unit price per linear feet of barrier provided, placed, and accepted. Price and payment constitute full compensation for:

1. Providing, placing, painting, and maintaining barriers; and
2. providing, installing, maintaining, and replacing reflector panels.

B. The Department will pay the accepted quantities of relocated temporary PCC safety barrier and reflector panels at the contract unit price per linear feet. Price and payment constitute full compensation for:

1. Removing barrier from the existing location;
2. temporary storage at the job site;
3. providing paint and painting;
4. placing at a new location; and
5. maintaining and replacing reflector panels.

C. The Department will pay the quantity of installing pins at the contract unit price per linear foot of pinning required to restrain a temporary PCC safety barrier. Price and payment constitute full compensation for providing and placing all materials and setting pin.

D. The Department will pay the quantity of removing pins at the contract unit price per linear foot of pins required to un-restrain a temporary PCC safety barrier. Price and payment constitute full compensation for removing pins and sealing holes from pins.

E. The Department does not consider barriers the contractor moves to access work as relocated barrier and will make no additional payment for these moves.

F. The Department will pay the accepted quantities of glare screen at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Providing, installing, and maintaining glare screen;
2. replacement of glare screen damaged by traffic; and
3. removal.

G. The Department will only pay for the initial installation of glare screen on the barrier and will not pay for re-installations on subsequent barrier relocations.

ITEM	DESCRIPTION	UNIT
807008	GLARE SCREEN	LF
807020	PROVIDE AND PLACE TEMPORARY PCC SAFETY BARRIER	LF
807021	RELOCATE TEMPORARY PCC SAFETY BARRIER	LF
807022	REMOVE TEMPORARY PCC SAFETY BARRIER	LF
807023	INSTALL TEMPORARY PCC SAFETY BARRIER PINS, IN BITUMINOUS PAVEMENT	LF
807024	INSTALL TEMPORARY PCC SAFETY BARRIER PINS, IN CONCRETE	LF
807025	REMOVE TEMPORARY PCC SAFETY BARRIER PINS, FROM BITUMINOUS PAVEMENT	LF
807026	REMOVE TEMPORARY PCC SAFETY BARRIER PINS, FROM CONCRETE	LF

SECTION 808 — TRUCK MOUNTED ATTENUATOR

808.1 Description.

This work consists of providing and maintaining truck mounted attenuators (TMA).

808.2 Materials.

Not applicable.

808.3 Construction.

A. Positioning the TMA:

1. Use the TMA in accordance with the DE MUTCD.
2. Position the TMA so the distance between the front bumper of the shadow vehicle and the closest point of the work area is in accordance with the manufacturer's roll-ahead recommendations. Keep a copy of the manufacturer's recommended roll-ahead distance in the shadow vehicle at all times.
3. Place the TMA so the equipment does not block driveways, commercial vehicle entrances, or streets and does not interfere with 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 work.
5. Use additional TMAs if the distance between what the TMA is protecting and the front of the shadow vehicle is at least twice the recommended roll ahead distance.

808.3.1 Equipment.

A. Provide a shadow vehicle, driver, and truck or a TMA.

1. Provide a shadow vehicle with a valid registration, a registration number plate, current inspection documentation, weight verification, and proof of insurance.
2. Provide operators that possess a valid driver's license of the required class to operate the shadow vehicle.
3. Provide truck or trailer mounted style TMA meeting the crash testing requirements of MASH.
   a. Submit the latest version of MASH eligibility letters in accordance with Section 801.2.
   b. Ensure a Type I TMA meets the requirements of Test Level 2. 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.
4. Attach the TMA to the back of the shadow vehicle in accordance with the manufacturer's recommendations.
5. Provide a shadow vehicle in accordance with the TMA manufacturer's recommendations for weight requirements.
   a. Keep a weight ticket from a certified scale house in the vehicle at all times indicating the weight of the shadow vehicle.

b. Secure the shadow vehicle's counterweight in accordance with Federal motor vehicle guidelines, so the counterweight does not shift when braking or cause an impact with the TMA.

6. Cover the back of the TMA with 6-inch diagonal inverted "V" stripes of alternating yellow retroreflective and black material, placed 6-inches apart.
7. Provide a large rotating amber beacon or strobe light on the shadow vehicle in accordance with the DE MUTCD.
8. Provide a Type C arrow board on the TMA in accordance with the DE MUTCD and Section 802. For proper acceptance, provide documentation showing that the TMA and arrow board combination meets MASH crash testing criteria.
9. Operate the TMA and arrow panel from the cab of the shadow vehicle. Ensure that the operator can raise and lower the TMA and the arrow board and that the operator can change the display on the arrow board from inside the cab.
10. Make the shadow vehicle and the TMA available for inspection upon request before starting work.

B. Maintain the truck or TMA as follows:

1. Repair and replace the TMA or shadow vehicle should either vehicle become damaged. Submit certification of repairs to the engineer before putting the damaged vehicle back in service.
2. Make arrangements with the TMA supplier to have replacement components for the TMA readily available for immediate repair.
3. Remove the TMA immediately from the project upon discovery, or notification of, damage and replace with an operable TMA or suspend the work requiring the TMA.

808.4 Method of Measurement.

The Department will measure TMAs as the actual number in place on the roadway and protecting active construction operations per calendar day. A calendar day consists of any approved usage within 24-hours of placing the device. The Department will measure each TMA only once in a 24-hour period, regardless of how many times the contractor relocates the TMA within the same project. When the contractor uses a TMA for part of a day, the Department will measure it as 1 each day.

808.5 Basis of Payment.

A. The Department will pay for truck mounted attenuator at the contract unit price per each day. Price and payment constitute full compensation for:

1. Providing, positioning, and maintaining the TMA and Type C arrow boards;
2. the shadow vehicle and driver;
3. repair or replacement of the unit; and
4. removal.

ITEM	DESCRIPTION	UNIT
808001	PROVIDE AND MAINTAIN TRUCK MOUNTED ATTENUATOR, TYPE I	EA-DY
808002	PROVIDE AND MAINTAIN TRUCK MOUNTED ATTENUATOR, TYPE II	EA-DY

SECTION 809 — TEMPORARY IMPACT ATTENUATOR

809.1 Description.

This work consists of providing, installing, relocating, maintaining, and removing temporary impact attenuators (TIA).

809.2 Materials.

Not applicable.

809.3 Construction.

809.3.1 Equipment.

A. TIAs.

1. Provide TIAs of the type specified in the contract in accordance with Section 724.
2. Provide ASTM D4956 Type IV retroreflective sheeting on the nose of the TIA facing traffic. Provide sheeting with:
   a. Alternating 3-inch minimum wide yellow and black stripes;
   b. stripes positioned at a 45-degree angle pointing down towards the side where traffic will pass the impact attenuator; and
   c. covering the entire TIA nose.
3. Meet MASH crash testing requirements.
4. Select TIAs from the Design Resource Center Approved Products List.
5. Provide the engineer with a written description of the TIAs planned for use. Submit TIA shop drawings and manufacturer's installation instructions.
6. Provide and maintain the availability of 1 complete stand-by replacement TIA of each type used at a location approved by the engineer.

B. Sand Crash Cushions.

1. Provide sand crash cushions in accordance with the contract consisting of an array for the design speed of the roadway.
2. Use sand crash cushions only when specified in the contract or approved by the engineer.
3. For the sand and salt mixture in sand crash cushions, provide:
   a. Clean, loose sand with a density of 100 pounds per cubic foot and a moisture content of no more than 3 percent.
   b. A mixture in accordance with manufacturer's recommendations. If no recommendations are available, the mixture must contain 10 to 20 percent rock salt by volume.
   c. Certification to the engineer that the sand and salt mixture meets these requirements before installing the sand crash cushion array.
4. Provide 1 complete stand-by replacement sand crash cushion array.

809.3.2 TIA and Sand Cushion Placement, Repair, Relocation, and Removal.

A. Place TIAs in accordance with Section 724, at the locations specified in the contract, or as directed by the engineer.

B. Repair TIAs in accordance with manufacturer's requirements within 24-hours of damage notification. Provide written certification of repairs. Replace if necessary.

C. Relocate TIAs by removing anchor pins completely from the pavement and filling the remaining holes with approved epoxy material. Do not cut pins flush with pavement. Provide written certification, from installers certified by the TIA manufacturers, of proper TIA relocation.

D. Remove TIAs by removing anchor pins completely and filling the remaining holes with approved epoxy material. Do not cut the anchor pins flush with the pavement.

E. Install sand crash cushions in accordance with the manufacturer's instructions.

F. Replace damaged cushions within 24-hours of damage notification. Refer to the manufacturer's recommendations for full or partial replacement of the array.

809.4 Method of Measurement.

A. The Department will measure TIAs as the number of TIAs provided, placed, and accepted.

B. The Department will measure sand crash cushions as the number of individual sand crash cushion barrels provided and accepted, regardless of barrel weight.

C. The Department will measure the number of damaged and replaced sand crash cushions as the number of barrels replaced and accepted, regardless of barrel weight.

809.5 Basis of Payment.

A. The Department will pay for providing TIAs at the contract unit price per EACH. Price and payment constitutes full compensation for:

1. Providing each type of TIA specified in the contract; and
2. providing 1 stand by replacement for each type of TIA specified in the contract.

B. The Department will pay for installing TIAs at the contract unit price per EACH. Price and payment constitute full compensation for:

1. Installing or removing a TIA system; and
2. repairing or replacing damaged TIAs.

C. The Department will pay for relocating TIAs at the contract unit price per EACH. Price and payment constitute full compensation for relocating and installing a TIA system.

D. The Department will pay for providing sand crash cushion barrel at the contract unit price per EACH. Price and payment constitute full compensation for:

1. Providing individual sand crash cushion barrels with sand and salt mixture; and
2. providing 1 complete stand-by replacement array.

E. The Department will pay for installing sand crash cushion barrel at the contract unit price per EACH. Price and payment constitute full compensation for installing or removing sand crash cushion barrels.

F. The Department will pay for relocating sand crash cushion barrel at the contract unit price per EACH. Price and payment constitute full compensation for relocating sand crash cushion barrels.

G. The Department will pay for replacing sand crash cushion barrel at the contract unit price per EACH. Price and payment constitute full compensation for:

1. Replacing damaged sand crash cushion barrels;
2. removing and disposing of damaged barrels; and
3. installing new barrels.

ITEM	DESCRIPTION	UNIT
809001	INSTALL TEMPORARY IMPACT ATTENUATOR	EACH
809002	PROVIDE TEMPORARY IMPACT ATTENUATOR – GATING, NON-REDIRECTIVE, TEST-LEVEL 2	EACH
809003	PROVIDE TEMPORARY IMPACT ATTENUATOR – GATING, NON-REDIRECTIVE, TEST-LEVEL 3	EACH
809004	PROVIDE TEMPORARY IMPACT ATTENUATOR – NON-GATING, REDIRECTIVE, TEST-LEVEL 2	EACH
809005	PROVIDE TEMPORARY IMPACT ATTENUATOR – NON-GATING, REDIRECTIVE, TEST-LEVEL 3	EACH
809006	RELOCATE TEMPORARY IMPACT ATTENUATOR	EACH
809007	PROVIDE SAND CRASH CUSHION BARREL	EACH
809008	INSTALL SAND CRASH CUSHION BARREL	EACH
809009	RELOCATE SAND CRASH CUSHION BARREL	EACH
809010	REPLACE SAND CRASH CUSHION BARREL	EACH
809011	PROVIDE TEMPORARY IMPACT ATTENUATOR - WIDE BAY, NON-GATING, REDIRECTIVE , TEST-LEVEL 2	EACH
809012	PROVIDE TEMPORARY IMPACT ATTENUATOR - WIDE BAY, NON-GATING, REDIRECTIVE , TEST-LEVEL 3	EACH

SECTION 810 — TEMPORARY WARNING SIGNS

810.1 Description.

This work consists of fabricating, providing, placing, relocating, maintaining, and removing temporary warning signs.

810.2 Materials.

A. Sign body material – in accordance with the and compliant with the latest version of MASH in accordance with Section 801.2.

B. Sizes and sign legends – in accordance with the DE MUTCD, the contract, and the FHWA Standard Highway Signs Book. If a conflict exists between the DE MUTCD, the contract, and the FHWA Standard Highway Signs Book, the contract takes precedence.

C. Retroreflective sign sheeting – in accordance with the DE MUTCD. Sheeting colors in accordance with the requirements of the DE MUTCD.

D. Ground mounted sign breakaway posts – meeting MASH crash testing requirements with eligibility letters in accordance with Section 801.2.

E. Temporary breakaway sign stands – In accordance with the latest version of MASH in accordance with Section 801.2

F. Sign covers – Plastic material 3-mils or thicker, black vinyl, black corrugated plastic, or approved equivalent.

810.3 Construction.

A. Temporary Ground-Mounted Signs.

Mount temporary signs facing traffic on ground-mounted sign posts when the signs are intended for more than 3 consecutive calendar days of use.

B. Only use temporary sign stands for signs facing traffic for a period longer than 3 consecutive calendar days, in the following situations:

1. To avoid drilling through permanent concrete to ground-mount signs on concrete islands in the median of a divided highway or other similar locations.
2. When a documented conflict exists with a utility, pedestrian access, or other permanent fixture and it is not possible to make field adjustments to the sign location. Provide documentation of the conflict to the engineer before using the temporary sign stand.

C. Install sign posts in accordance with the manufacturer's instructions at the locations shown in the contract. If there is a discrepancy between field conditions and what the contract shows, including the presence of other regulatory, warning, or guide signs, adjust placement of the sign with the engineer's approval.

D. Mount signs at the heights specified in the DE MUTCD, measured from the bottom of the sign to top of the roadway or sidewalk surface.

E. Do not install temporary signs on the same posts as existing regulatory, warning, or guide signs.

F. Completely cover a sign with approved sign cover material, if the sign is not applicable to the work taking place at the time.

G. Remove the sign and the entire post, including the section of post embedded in the ground, at project completion or completion of the construction phase the sign was needed for.

H. Temporary Stand-Mounted Signs.

1. Place sign stands at the locations shown in the contract or as required by the DE MUTCD.
2. Weight the sign stands with ballast in accordance with the manufacturer's requirements and as follows:
   a. On high-speed expressways or other situations where temporary sign stands may be susceptible to overturning in the wind, weigh the stands with ballast.
   b. Install ballast on the lower part of the frame or the stays of the temporary sign stand to provide the required ballast.
   c. If a sand ballast is used, it must consist of a suitable mixture of material to preclude the ballast from freezing.
3. Mount the signs on the stands at the height specified in the DE MUTCD, measured from the bottom of the signs to top of the roadway or sidewalk surface.
4. Remove signs and temporary sign stands from the roadway clear zones in accordance with the latest version of the AASHTO Roadside Design Guide when no longer needed.
5. Do not place temporary sign stands within bicycle lanes, sidewalks, or shared use paths.

I. Sign Maintenance.

1. Replace or repair signs that are not upright, vertically aligned, and facing the direction of travel 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 801.2.
3. Maintain signs, sign stands, and the area around the sign stands. Ensure that the signs and stands remain in good working condition at all times. Keep the area around sign posts and the sign stands free of debris.

810.4 Method of Measurement.

The Department will measure temporary warning signs as the number of signs in place and facing traffic each calendar day.

810.5 Basis of Payment.

A. The Department will pay the accepted quantities of temporary warning signs at the contract unit price per each calendar day. Price and payment will constitute full compensation for:

1. Providing and placing signs, sign posts, or temporary sign stands;
2. fabricating signs;
3. ballast material;
4. sign covers;
5. relocating signs, sign stands, or sign posts; and
5. signs, sign stands, or sign posts removal.

B. The Department will pay for sign maintenance and relocation in accordance with Section 801.

ITEM	DESCRIPTION	UNIT
810001	TEMPORARY WARNING SIGNS AND PLAQUES	EA-DY

SECTION 811 — FLAGGERS

811.1 Description.

This work consists of providing traffic control flaggers.

811.2 Materials.

Not applicable.

811.3 Construction.

Provide certified flaggers meeting the requirements of the DE MUTCD.

811.4 Method of Measurement.

The Department will measure flaggers as the number of hours flaggers were flagging traffic.

811.5 Basis of Payment.

A. The Department will pay the accepted quantities for flaggers at the contract unit price per hour for each flagger. Price and payment constitute full compensation for:

1. Flagging personnel;
2. flagging equipment;
3. retroreflectorized clothing;
4. approved communication devices; and
5. flagging certification.

ITEM	DESCRIPTION	UNIT
811001	FLAGGER, NEW CASTLE COUNTY	HOUR
811002	FLAGGER, KENT COUNTY	HOUR
811003	FLAGGER SUSSEX COUNTY	HOUR
811013	FLAGGER, NEW CASTLE COUNTY, OVERTIME	HOUR
811014	FLAGGER, KENT COUNTY, OVERTIME	HOUR
811015	FLAGGER, SUSSEX COUNTY, OVERTIME	HOUR

SECTION 812 — CERTIFIED TRAFFIC CONTROL SUPERVISOR

812.1 Description.

This work consists of providing a certified traffic control supervisor.

812.2 Materials.

Not applicable.

812.3 Construction.

A. Provide a certified traffic control supervisor for the term of the project in accordance with the general notes in the contract.

B. The Department will accept certifications for traffic control supervisors from the ATSSA.

C. Submit a copy of the traffic control supervisor's certification at the pre-construction meeting.

D. Ensure that the traffic control supervisor checks in and checks out daily with the engineer before beginning and ending traffic control supervisor duties.

E. The traffic control supervisor is responsible for traffic and temporary traffic control device maintenance throughout the project duration and location. The traffic control supervisor's duties are:

   a. Supervising placement, removal, operations, and maintenance of temporary traffic control devices and work zone setups.

   b. Preparing a Daily Log to record traffic control maintenance including the number and location of temporary traffic control devices, placement times, changes, and repairs.

   c. Supervising the temporary traffic control zone daily, including detour route inspection, deficiency documentation, and defining corrective actions to address deficiencies.

   d. Serving as the liaison with the engineer concerning the temporary traffic control devices and traffic maintenance.

   e. Having no other responsibilities other than what is outlined in this section.

F. If construction methods require temporary traffic control to extend beyond a single working shift within a one-day period on the same project, provide a second traffic control supervisor to relieve the original traffic control supervisor, at the discretion of the engineer.

G. Traffic control supervisors shall only serve 1 project.

812.4 Method of Measurement.

The Department will not measure the quantity of certified traffic control supervisors.

812.5 Basis of Payment.

The Department will pay for the certified traffic control supervisor in accordance with Section 801.

SECTION 813 — TEMPORARY BARRICADES

813.1 Description.

This work consists of providing, placing, relocating, maintaining, and removing temporary barricades.

813.2 Materials.

A. Temporary barricades, Type III in accordance with the DE MUTCD.

B. Temporary barricades, Type II in accordance with the DE MUTCD.

C. Crashworthy barricades in accordance with the latest version of MASH and Section 801.2.

813.3 Construction.

A. Type III Temporary Barricades.

1. Use barricade rails in accordance with the DE MUTCD and with a minimum rail length of 6-feet without signs and 10-feet with signs installed on the barricade. A minimum rail length of 4-feet is required for barricades used for a sidewalk closure.
2. Install Type III barricades for road closures, diversion points, or sidewalk closures in accordance with the DE MUTCD, and the contract. Place barricades for:
   a. Road closures so the barricades cover the entire width of the roadway from edge-of-pavement to edge-of-pavement.
   b. Diversion points to the far right of the travel lane. Place the barricade in the shoulder if a shoulder exists. Place the barricade at the edge of the roadway if no shoulder exists.
   c. Sidewalk closures so the barricades cover the entire width of sidewalk from edge-of- sidewalk to edge-of-sidewalk.
3. Support barricades with approved ballast on at least 2 corners of the barricade base.
4. Mount signs on barricades in accordance with the contract or the DE MUTCD. Mount signs at least 12-inches above the ground or surface.
5. Replace barricades within 24-hours after notification of damage or when the barricades no longer meet the “marginal” criteria of the ATSSA quality guidelines brochure in accordance with Section 801.3.

B. Type II Temporary Barricades.

1. Use barricade rails in accordance with the DE MUTCD and with a minimum rail length of 2-feet.
2. When used for pedestrian channelization, the rails must be continuous and mounted in accordance with ADA in order to provide for a cane detectable bottom rail and a top hand rail.
2. Install Type II barricades for sidewalk closures in accordance with DE MUTCD, and the contract. Place barricades at the point of full sidewalk closure so the barricades cover the entire width of the sidewalk from edge-of-sidewalk to edge-of-sidewalk.

C. Pedestrian Channelizing Barricade System

1. Construct the barricade with continuous delineation along the designated walkway for use as a channelization device in accordance with ADA requirements and the requirements of the DE MUTCD.

2. Assemble the barricade in accordance with manufacturer's recommendations.
3. Provide continuous upper and lower rails for hand or cane trailing.
    a. Install upper rail of barricade a minimum 36-inches above the ground, measured from the ground to the top of the upper rail.
    b. Install lower rail of the barricade a minimum of 1 1/2-inch above the ground, measured from the ground to the bottom of the lower rail.
4. No portion of the barrier structure or supports may extend into the walkway more than 3/4-inch further than the common plane formed by the upper and lower rails.
5. Ensure that barricade joints are smooth and snag-resistant to accommodate safe hand trailing.
6. Provide accommodations for attachment of audible information devices.
7. Pedestrian channelizing barricades cannot be used as road closure barricades or provide positive protection between the temporary walkway and vehicular traffic.
8. Remove pedestrian channelizing when it is no longer needed.

813.4 Method of Measurement.

A. The Department will measure the length of Type II and Type III temporary barricades along the top rail in linear feet every calendar day the barricades are in place and facing traffic.

B. The Department will measure the quantity of pedestrian channelizing barricade system in linear feet per day.

813.5 Basis of Payment.

A. The Department will pay the accepted quantities of Type II and Type III temporary barricades at the contract unit price per linear foot for every calendar day the barricades are in place and facing traffic. Price and payment constitute full compensation for providing and placing barricades, ballast material, and barricade removal.

B. The Department will pay the accepted quantities of Type II temporary barricades at the contract unit price per linear foot for every calendar day the barricades are in place and facing pedestrian traffic. Price and payment constitute full compensation for providing and placing barricades, ballast material, and barricade removal.

C. The Department will pay for pedestrian channelizing barricade system at the contract unit price per linear foot per day. Price and payment constitute full compensation for:
    1. Providing certification; and
    2. providing, placing, maintaining, and relocating barricades as required.

D. The Department will pay for barricade maintenance and relocation in accordance with Section 801.

E. The Department will pay for signs mounted on barricades in accordance with Section 810.

ITEM	DESCRIPTION	UNIT
813001	TEMPORARY BARRICADES, TYPE III	LF-DY
813002	TEMPORARY BARRICADES, PEDESTRIAN, TYPE II	LF-DY
813003	PEDESTRIAN CHANNELIZING BARRICADE SYSTEM	LF-DY

SECTION 818 — SIGN PANELS

818.1 Description.

This work consists of fabricating and providing sign panel overlays and new sign panels.

818.2 Materials.

A. Retroflective Sign Sheeting.

1. Wide angle, prismatic, retroreflective sheeting meeting the properties of ASTM D4956 Type IV, Type IX, or Type XI sheeting.
2. Prismatic lens elements with a distinctive interlocking pattern visible from the face of a smooth surface.
3. Pre-coated adhesive protected by an easily removable liner.

B. Aluminum Sign Panels.

1. Aluminum sheet type in accordance with ASTM designation B209 (alloy 6061-T6 or 5052-H38).
2. Stringers or horizontal structural sign supporting members and vertical connections of 6061-T6 or 6062-T6 ASTM B221 aluminum alloy.
3. Reflectorized sign panels.
4. Sign Hardware.
   a. Stainless or galvanized steel.
   b. 2024-T4 aluminum alloy ASTM B211 or ASTM B221.
   c. Hardware for attachment to overhead members:
      i. Type 304 passivated stainless steel.
      ii. Type 302 stainless steel alloy lock washers.
   d. Sign support structure connections.
      i. Steel in accordance with ASTM designation A36.
      ii. Galvanized in accordance with ASTM designation A123.

C. Overhead Extruded Aluminum Sign Panels.

1. Sign panels and edge strips in accordance with B 221, alloy 6063 T6.
2. Clear anodized hardware, in accordance with 1 of the following: ASTM B209, alloy 2024 T4; ASTM B-211, alloy 2024 T4, 6262 T9, 6061 T6, 7075 T6, or 2017 T4.
3. Type IX or XI retroreflective sheeting.

D. Sign Panel Overlays.

1. Flat aluminum sheet in accordance with ASTM designation B209 (alloy 6061-T6).
2. Minimum panel sheet thickness is 0.08-inch.

E. Connections Section 1039

818.3 Construction.

818.3.1 Applicable Documents.

A. The versions of the following documents in effect on the date of the bid advertisement or request for proposal form a part of this specification to the extent specified here:

1. ASTM E810 Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting.
2. AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals.
3. DE MUTCD.
4. FHWA Standard Highway Signs and Markings.
5. Delaware Sign Book.

818.3.2 Submittals.

A. Submit working drawings in accordance with Section 818.3.1 and show the following:

1. Sheeting type – legend and background;
2. colors;
3. legend;
4. proposed spacing of letters; and
5. locations, dimensions, and arrangements of symbols and borders.

B. Working drawings are not required for signs provided in the Delaware Sign Book or signs that are detailed in the Plans.

818.3.3 Design.

A. Roadside Sheet Aluminum Sign Panels.

1. Design sign panels and their connections to supports for applicable loadings and allowable stresses specified for the supports.
   a. Ensure all panels, stiffeners, and sub-framing are in accordance with AASHTO Standard Specifications for Structural Supports for Highway signs, Luminaires, and Traffic Signals with subsequent revisions.
   b. Submit drawings showing the details for fabricating panels and support connections for prior approval.
2. Fabricate sign panel sections from standard width, aluminum sheets with widths no less than 36-inches wide and no more than 5 1/2-feet wide, except that the Department will not allow more than 1 sheet of 2-foot minimum width.
3. Fabricate sign panel sections up to 12-feet tall using flat aluminum sheets that run from the top edge to the bottom edge of the sign face without horizontal joints.
4. Fabricate sign panel sections over 12-feet tall from 2 or more sheets with horizontal joints that butt and fasten together for simplified handling and erection.
   a. Locate each horizontal joint in sign panel sheets at the point of contraflexure in the sign face.
   b. Fabricate the bottom sheet from material that is 12-feet tall.
   c. Fabricate the smaller top sheet no less than 2-feet tall.

d. Ensure 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 the fastenings shown in the contract.

b. Design fastenings to carry the full design load with a safety factor of 1.6 against the minimum yield stress of the materials.

c. Signs over 9-square feet in area shall be fastened with washers in addition to standard hardware.

6. Provide sign panel sections with backing strips at the joints, held in place to keep the abutting panel sections in alignment.

a. Apply sign panel fastenings and backing strips, with the exception of those used to fasten letters, symbols, and the sign face border, without causing visible projections or indentations of the sign face.

b. Design each sign panel section to engage and hang from 2 or more horizontal structural members of the supporting frame.

7. Supporting Frame.

a. Construct a supporting sign frame consisting of horizontal and vertical stringers in accordance with the contract.

b. Fabricate the horizontal supporting sign members using 1 piece of new material.

c. Locate splices at points of contraflexure. Keep the number of splices to a minimum for large signs that require stringer splicing.

8. Sign Panel Size.

a. Fabricate sign panels that include a reflective sheeting background, complete with demountable, direct applied, or silk-screened copy.

b. Base the sign panel sizes containing copy in accordance with the plans on the manufacturer's spacing charts.

c. Place all letters in accordance with manufacturer's spacing charts.

d. Use 6-inch increments for the overall horizontal and vertical dimensions.

B. Overhead Extruded Aluminum Sign Panels.

1. Provide extruded aluminum sign panels with copy in accordance with the contract.

2. The Department will allow use of the permitted maximum thickness of 0.100-inch for the exposed surface of extruded aluminum sign panels. Equip only with notched corners.

3. Fabricate extruded aluminum sign panels from individual extrusions that are 12-inches wide. Assemble extruded aluminum sign panels such that the individual extrusions connect 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:

The Department will allow extruded sections 6-inches wide where required by the sign height or exit panel. The Department will allow no more than one, 6-inch panel per individual sign or exit panel.

4. Apply reflective sheeting to extruded panels so that it extends approximately 3/8-inch over each side in the narrow direction and remains adhered to the panel.
5. Place an edge strip on both sides of extruded panel signs.

818.3.4 Construction.

A. Sign Face Finishing.

1. Apply retroreflective sheeting to the aluminum panels after degreasing and etching the sign panel, in accordance with sheeting manufacturer's recommendations.
   a. Apply the sheeting only when the sheeting and air temperature is above 50 degrees F.
2. Whenever necessary to construct the background of a sign face with 2 or more pieces of retroreflective sheeting, match for color and prismatic pattern before application and sign fabrication.
   a. The Department will reject sheeting with non-uniform shading or an undesirable contrast between adjacent widths of applied sheeting.
   b. Ensure 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 necessary for backgrounds.
   d. Do not use remnants, scraps, or odd sized pieces of sheeting for sign fabrication.
   e. Butt or overlap joints between retroreflective sheeting no more than 3/8-inch.
   f. Do not use horizontal joints between retroreflective sheeting sections.
   g. Create a "watershed" seam to prevent sediment and water from entering within the sheeting joint.

B. Sign Panel Erection.

1. The engineer may determine that certain sign messages are not ready for public display at the time of sign erection. Cover and secure the panels of such signs with an opaque material in accordance with Section 810 until the sign messages are ready for public display.
2. Provide and place identification tags or decals on the sign panels that state the contract number and the month and year of erection. Place tags on the lower back side of the panel nearest the roadway shoulder.
3. All sign panels shall be erected with any and all supplemental hardware in accordance with the Standard Construction Details.

C. Sign Panel Overlay Installation.

1. Field verify panel overlay sizes before fabrication.
2. Attach logos to the sign panel overlay in accordance with the contract.
3. Install sign panel overlays to existing signs in accordance with the contract.
4. Use rivets to attach the sign panel overlay to the existing sign.

818.3.5 Maintenance and Evaluation.

Date signs at the time of installation. Provide date stickers in accordance with the Delaware Sign Book and the Standard Construction Details.

818.4 Method of Measurement.

The Department will measure the quantity of sign panels as the number of square feet of front sign face surface area of sign panels constructed and accepted. The Department will measure the signs as complete shapes and will make no area deductions for rounded corners.

818.5 Basis of Payment.

A. The Department will pay the quantity of sign panel at the contract unit price per square foot. Price and payment will constitute full compensation for:

1. Providing and placing sign panels with retroreflective materials, copy, symbols, borders;
2. providing and placing decals; and
3. connections to supports.

B. The Department will consider the cost of removing, separating material types, and transporting existing sign panels and hardware to the DelDOT sign shop as included in the pay items below, unless otherwise indicated in the contract.

ITEM	DESCRIPTION	UNIT
818001	SUPPLY OF ROADSIDE FLAT SHEET ALUMINUM SIGN PANEL, TYPE IV RETROREFLECTIVE SHEETING	SF
818002	SUPPLY OF ROADSIDE FLAT SHEET ALUMINUM SIGN PANEL, TYPE IX RETROREFLECTIVE SHEETING	SF
818003	SUPPLY OF ROADSIDE FLAT SHEET ALUMINUM SIGN PANEL, TYPE XI RETROREFLECTIVE SHEETING	SF
818010	SUPPLY OF OVERHEAD OR I-BEAM EXTRUDED ALUMINUM SIGN PANEL	SF

SECTION 819 — SIGN POSTS

819.1 Description.

This work consists of providing, placing, and removing sign posts.

819.2 Materials.

A.	Galvanized Telescoping Steel Sign Posts	Section 1072.1
B.	Fasteners and Hardware	Section 1072.1.K
C.	4” PVC Pipe	Section 1031

819.3 Construction.

A. Install or Remove Traffic Sign Posts.

1. Install Sign Posts.
   a. Follow Miss Utility procedures before installing sign posts to avoid damaging existing utilities.
   b. Place sign posts in accordance with the DE MUTCD and MASH.
   c. Install telescoping steel sign posts as follows:
      i. Install sign posts, base posts, corner bolts, and associated hardware in accordance with the Standard Construction Details.
      ii. For signs mounted in a concrete island where no hole exists, core a 4-inch diameter hole for the post.
2. Remove Sign Posts.
   a. Remove the post, including the part in the ground. Do not cut posts flush with the ground.
   b. If the sign and/or post are designated for re-installation, neatly stockpile the materials safe from damage until the material is re-installed. Dispose of signs and/or posts not planned for re-installation.
   c. Remove nuts, bolts, and other connections between the signs and the posts.
      i. If a traffic sign is mounted on a single post, remove the sign post from the ground and then remove the sign from the post.
      ii. If a traffic sign is mounted to multiple posts, remove the traffic sign from the posts and then remove the posts from the ground.
   d. Backfill the post hole and grade the disturbed ground.

B. Install or Remove Traffic Signs.

1. Install Traffic Signs.
   a. Install signs on posts as follows:
      i. Mount the sign at a height in accordance with the DE MUTCD and MASH.
      ii. Except for YIELD signs, mount a sign assembly with a single sign totaling more than 9 square feet on 2 posts.

b. Inspect each sign location to determine if clearing is required to maintain sight lines. Clear in accordance with Section 201 and as directed by the engineer.

2. Remove Traffic Signs.

a. If a traffic sign is designated for replacement, leave the sign post in place in the ground and remove the traffic sign from the post.

819.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Providing sign posts as the number of sign posts provided.
2. Installing or removing sign posts as the number installed or removed.
3. Installing holes in existing concrete as the number of holes bored and accepted.
4. Installing or removing traffic signs as the number of signs installed or removed from sign posts.

819.5 Basis of Payment.

A. The Department will pay the quantity of providing sign posts at the contract unit price per each. Price and payment constitutes full compensation for providing all materials including the steel sign post, base post, post extensions, and all hardware to install the post.

B. The Department will pay the quantity of installing or removing sign posts at the contract unit price per each. Price and payment constitutes full compensation for installing or removing sign posts and grading disturbed area.

C. The Department will pay the quantity of installing or removing traffic signs at the contract unit price per each. Price and payment constitutes full compensation for installing or removing traffic signs and providing and installing all sign mounting hardware.

D. The Department will pay for the quantity of holes bored into existing concrete at the contract unit price per each. Price and payment constitutes full compensation for boring holes.

E. The Department will pay for clearing and grubbing in accordance with Section 201. If the Bid Proposal does not include 201000, this Work will be incidental to the traffic sign item.

F. The Department will pay for providing signs in accordance with Section 818.

G. The Department will pay for the quantity of all other sign posts and hardware as listed below. Price and payment constitutes full compensation for providing all materials.

ITEM	DESCRIPTION	UNIT
819001	PROVIDE GALVANIZED TELESCOPING SIGN POST	EACH
819002	INSTALL OR REMOVE GALVANIZED TELESCOPING SIGN POST	EACH
819003	INSTALL OR REMOVE TRAFFIC SIGNS	EACH
819010	INSTALLATION OF 4” DIAMETER HOLE, LESS THAN OR EQUAL TO 6” DEPTH	EACH
819011	INSTALLATION OF 4” DIAMETER HOLE, GREATER THAN 6”	EACH
819101	GALVANIZED STEEL SIGN POST ONLY, 9’ X 2”	EACH
819102	GALVANIZED STEEL SIGN POST ONLY, 10’ X 2”	EACH
819103	GALVANIZED STEEL SIGN POST ONLY, 11’ X 2”	EACH

ITEM	DESCRIPTION	UNIT
819104	GALVANIZED STEEL SIGN POST ONLY, 12’ X 2”	EACH
819105	GALVANIZED BASEPOST SECTION ONLY, 36” X 2.25”	EACH
819106	GALVANIZED BASEPOST SECTION ONLY, 18” X 2.25”	EACH
819107	UNC CORNER BOLT, GRADE 5, .3125”, COMPLETE WITH NUT	EACH
819108	GALVANIZED TELESCOPING STEEL SIGN POSTS, 9’X2”, COMPLETE W/BASEPOSTS AND HARDWARE	EACH
819109	GALVANIZED TELESCOPING STEEL SIGN POSTS, 10’X2”, COMPLETE W/BASEPOSTS AND HARDWARE	EACH
819110	GALVANIZED TELESCOPING STEEL SIGN POSTS, 11’X2”, COMPLETE W/BASEPOSTS AND HARDWARE	EACH
819111	GALVANIZED TELESCOPING STEEL SIGN POSTS, 12’X2”, COMPLETE W/BASEPOSTS AND HARDWARE	EACH
819112	GALVANIZED TELESCOPING STEEL SIGN POSTS, 13’x2”, COMPLETE W/BASEPOSTS AND HARDWARE	EACH
819113	GALVANIZED TELESCOPING STEEL SIGN POSTS, 14’x2”, COMPLETE W/BASEPOSTS AND HARDWARE	EACH
819114	GALVANIZED TELESCOPING STEEL SIGN POSTS, 15’x2”, COMPLETE W/BASEPOSTS AND HARDWARE	EACH

SECTION 820 — BREAKAWAY I-BEAM SIGNS

820.1 Description.

This work consists of providing and placing or removing breakaway I-beam sign supports.

820.2 Materials.

A. Steel I-Beams	Section 615; Section 1039
B. Concrete	Section 1022
C. Reinforcement	Section 1037
D. Breakaway Assembly	Section 1072.2
E. Breakaway I-Beam Sign Foundation Hardware:	
1. Anchor Bolts	Section 1072.3.A
2. Nuts, bolts, cap screws	Section 1072.3.B
F. Borrow	Section 1001
G. Liquid Membrane-Forming Compounds for Curing	Section 1045.7

820.3 Construction.

A. Reinforced Concrete Sign Foundation.

1. Ensure that the foundation excavation does not exceed the foundation dimension by more than 1-foot in any one direction.
2. Place and secure reinforcement bar.
3. Set anchor bolts.
4. Place concrete in accordance with Section 610. Finish and cure in accordance with Section 610.3.6.
5. Backfill foundation in accordance with Section 207.
6. Dispose of remaining excavated material and grade the area around the foundation in accordance with the contract documents.
7. Return the area around the foundation to its original condition with mulching, seeding, or other landscaping as necessary.

B. Breakaway I-Beam Signs.

1. Submit working drawings in accordance with Section 105.4.
2. Provide written instructions and drawings for erecting sign structure components.
3. Store structural materials above the ground on platforms, skids, or other supports and keep free from the accumulation of foreign matter.
4. Straighten deformed structural material before laying out, punching, drilling, or otherwise working on the material in the shop. The Department will reject material with sharp kinks or bends.

5. Repair damaged galvanized areas using any of the 3 methods in accordance with ASTM A780. Meet the minimum coating thickness specified for the repair.
6. Follow the manufacturer's specifications and the contract for installing couplings, bolts, and sign mounts.
7. Install in accordance with the contract documents.

C. Repairing Existing I-Beam Sign Supports.

1. Remove broken couplings and bolts on existing I-beams and remove broken anchor bolts in existing concrete foundations.
2. Reuse existing I-beam supports as required by the engineer. Provide and install new couplings, bolts, hinge plates, and anchor bolts to re-install I-beam supports. Install I-beam supports in accordance with Section 820.3.B.
3. Replace damaged concrete base in accordance with 820.3.A.

D. Remove and dispose of existing I-beam sign supports shown in the contract as approved by the engineer.

E. Install or remove sign panels on I-beam sign supports:

1. Install sign panel on I-beam sign supports in accordance with the contract and the manufacturer's recommendations.
2. Remove existing sign panels from I-beam supports as approved by the engineer.

820.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Reinforced concrete sign foundation as the number of foundations constructed and accepted.
2. Breakaway I-beam sign posts as the number of linear feet of sign posts provided, placed, and accepted.
3. Breakaway coupling systems, bolt kits, and hinge plates as the number of devices provided, assembled, and accepted.
4. Breakaway I-beam sign mounts as the number of sign mounts installed or removed and accepted.
5. I-beam sign panels as the number of square feet of front sign face surface area of all sign panels placed and accepted.

820.5 Basis of Payment.

A. The Department will pay the quantity of reinforced concrete masonry sign foundations at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing all materials to construct sign foundations;
2. constructing sign foundations;
3. curing concrete;
4. providing and setting anchor bolts; and
5. returning the area around the sign foundation to its original condition.

B. The Department will pay the quantity of breakaway I-beam sign posts at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Providing breakaway I-beam sign posts; and
2. providing and assembling breakaway coupling systems, bolt kits, hinge plates, nuts, bolts, and cap screws and all other materials.

C. The Department will pay the quantity of breakaway coupling systems, bolt kits, and hinge plates at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing hinge plates, breakaway couplings, nuts, bolts, cap screws, and all other materials; and
2. assembling breakaway coupling systems.

D. The Department will pay the quantity of breakaway I-beam sign mounts installed or removed at the contract unit price per each. Price and payment constitute full compensation for installation or removal of sign mounts.

E. The Department will pay the quantity of sign panels on breakaway I-beam sign supports installed or removed at the contract unit price per square foot. Price and payment constitute full compensation for installation or removal of sign panels.

ITEM	DESCRIPTION	UNIT
820001	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-6	EACH
820002	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-8	EACH
820003	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-10	EACH
820004	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-12	EACH
820005	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-14	EACH
820006	REINFORCED CONCRETE MASONRY SIGN FOUNDATION, W-18	EACH
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
820014	SUPPLY AND INSTALLATION OF BOLT KIT FOR BREAKAWAY COUPLING	EACH
820015	SUPPLY AND INSTALLATION OF HINGE PLATE FOR BREAKAWAY COUPLING	EACH
820016	SUPPLY AND INSTALLATION OF BREAKAWAY COUPLING SYSTEM	EACH
820017	INSTALLATION OF BREAKAWAY I-BEAM SIGN POSTS	EACH
820018	REMOVAL OF BREAKAWAY I-BEAM SIGN POSTS	EACH
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

821.1 Description.

This work consists of providing, installing, or removing concrete barrier-mounted signs.

821.2 Materials.

A. Provide barrier mounted signs to the latest MASH compliance.

B.	Non-Shrink Grout	Section 1047.2
C.	Tubular Steel Post	A501
D.	Anchor Bolts	ASTM F 1554, GR 55
E.	Nuts	ASTM A194
F.	Plates and W6x12 Post	ASTM A706, Grade 36

821.3 Construction.

A. Install barrier-mounted sign supports in accordance with the manufacturer's recommendations.

B. Store structural materials above the ground on platforms, skids, or other supports and keep free from the accumulation of dirt, oil, acids, or other foreign matter.

C. Repair damaged galvanized areas in accordance with the manufacturer's recommendations.

D. Removing Barrier Mounted Sign Supports and I-Beams.

1. Remove the sign from the sign support or I-beam without damaging the sign.
2. Remove sign supports and mounting hardware from the barrier.
3. Plug remaining holes in the barrier with an approved non-shrink grout.

821.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Concrete barrier-mounted sign supports and I-beams as the number of sign supports provided, placed, and accepted.
2. Concrete barrier-mounted sign supports and I-beams as the number of sign supports removed.
3. Sign panels installed or removed on concrete barrier-mounted sign supports as the number of square feet of sign panel installed or removed and accepted.

821.5 Basis of Payment.

A. The Department will pay the quantity of concrete barrier-mounted sign supports and I-beams installed at the contract unit price per each. Price and payment constitute full compensation for providing and placing all materials.

B. The Department will pay the quantity of concrete barrier-mounted sign supports and I-beams removed at the contract unit price per each. Price and payment will constitute full compensation for removing all materials for the sign.

C. The Department will pay the quantity of sign panels installed or removed on concrete barrier-mounted sign supports at the contract unit price per square foot. Price and payment will constitute full compensation for installing or removing sign panels.

ITEM	DESCRIPTION	UNIT
821001	SUPPLY OF BARRIER MOUNTED SIGN SUPPORT, 4” POST	EACH
821002	SUPPLY OF BARRIER MOUNTED SIGN SUPPORT, 2” POST	EACH
821003	INSTALLATION OF BARRIER MOUNTED SIGN SUPPORT	EACH
821004	REMOVAL OF BARRIER MOUNTED SIGN SUPPORT	EACH
821005	INSTALLATION OF SIGN ON BARRIER MOUNTED SIGN SUPPORT	SF
821006	REMOVAL OF SIGN ON BARRIER MOUNTED SIGN	SF

SECTION 822 — OVERHEAD AND CANTILEVER SIGN PANELS

822.1 Description.

This work consists of placing, repositioning, or removing a sign panel on an overhead or cantilever structure.

822.2 Materials.

A.	Vertical Support Members	Section 1039
B.	Sign Panels	Section 818
C.	Sign Panel Overlays	Section 818.2.D

D. The contract will show if the contractor or the Department supplies the signs:

1. For Department-supplied signs, provide the DelDOT Sign Shop with the parameters for the signs to be fabricated in accordance with Section 818.
2. The Department will allow signs with pre-drilled holes for mounting.

822.3 Construction.

822.3.1 Submittals.

A. 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, DE MUTCD, and AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

B. Submit working drawings for the support members and connections to the support members in accordance with Section 105.4.

C. 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.

822.3.2 Installing, Repositioning, or Removing.

A. Installing Overhead and Cantilever Sign Panel.

1. Assemble sign panels in accordance with Section 818.
2. Install sign panels to the height specified in the contract documents. Measure height from the bottom of the sign panel to the top of the pavement.
3. Install sign panels and connect to overhead or cantilever structures, in accordance with the contract.

B. Repositioning an Existing Sign Panel.

1. The engineer will determine the horizontal location of the sign on the supporting structure.
2. Replace damaged or otherwise unsuitable connections at the engineer's direction.
3. Re-install the existing sign at the new location.

C. Removing an Existing Sign Panel from a Structure.

1. Remove the sign panel and connecting hardware.

2. Dispose of removed materials not planned for re-use.

822.4 Method of Measurement.

A. The Department will measure the quantity of signs:

1. Installed on overhead and cantilever structures as the number of square feet of signs installed and accepted.
2. Repositioned on overhead and cantilever structures as the number of square feet of signs repositioned and accepted.
3. Removed from overhead and cantilever structures as the number of square feet of signs removed.

822.5 Basis of Payment.

A. The Department will pay:

1. The quantity of overhead and cantilever signs installed at the contract unit price per square foot. Price and payment will constitute full compensation for installing sign panels.
2. The quantity of overhead and cantilever signs repositioned at the contract unit price per square foot. Price and payment will constitute full compensation for detaching signs from existing structures and re-installing at the new locations.
3. For providing, installing, relocating, removing, and cutting I-beam backing supports separately under the respective pay items listed below.
4. The quantity of overhead and cantilever signs removed at the contract unit price per square foot. Price and payment constitute full compensation for removing existing overhead signs and overhead sign lighting.

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 AND MAST ARM SIGN PANELS

823.1 Description.

This work consists of installing, repositioning, or removing a sign on a span wire or mast arm.

823.2 Materials.

A. Sign Panels Section 818

B. U-bolts, Nuts and Washers Section 1039

C. Span Wire Clamps

1. Dual face span wire clamps to hold street name signs and other span wire mounted signs.
2. Submit catalog cut to engineer.

D. Mast Arm Bracket

1. Single face mast arm or pole mount sign hardware.
2. Dual face mast arm or street name sign hardware.
3. Submit catalog cut to engineer.

E. Fabricate connections of industry standard material. The engineer will approve the connections.

823.3 Construction.

A. Mast Arm Installation.

1. Install mast arm bracket and associated hardware in accordance with the manufacturer's instructions.
2. Attach sign to bracket in accordance with bracket manufacturer's recommendations.
3. Install the sign a minimum height of 17-feet above the ground, measured from the pavement to the bottom of the sign.

B. Span Wire Installation.

1. Install span wire clamps and associated hardware in accordance with bracket manufacturer's recommendations.
2. Attach signs to the span wire clamp in accordance with manufacturer's recommendations.
3. Install the signs a minimum height of 17-feet above the ground, measured from the pavement to the bottom of the sign.

C. Repositioning Existing Sign on Pan Wire or Mast Arm.

1. The engineer will determine the horizontal location of the sign on the supporting structure.
2. Replace mounting hardware at the discretion of the engineer.

D. Removing Existing Signs on Span Wire or Mast Arms.

1. Remove existing signs and mounting hardware from mast arms or span wire in accordance with the contract.
2. Dispose of sign materials not planned for re-use.

823.4 Method of Measurement.

A. The Department will measure:

1. Sign installation on span wire or mast arms as the number of square feet of complete signs installed and accepted.
2. Existing sign repositioning on span wire or mast arms as the number of span wire or mast arm signs repositioned and accepted.
3. Existing sign removal from span wire or mast arms as the number of span wire or mast arm mounted signs removed.

823.5 Basis of Payment.

A. The Department will pay the quantity of:

1. Installed span wire or mast arm mounted signs at the contract unit price per square foot of sign installed and any applicable mounting hardware.
2. Repositioned span wire or mast arm mounted signs at the contract unit price per each. Price and payment constitute full compensation for providing, preparing, and placing all materials including new hardware.
3. Removed span wire or mast arm mounted signs at the contract unit price per each. Price and payment constitute full compensation for sign and hardware removal.

ITEM	DESCRIPTION	UNIT
823001	INSTALLATION OF SIGN ON SPAN WIRE OR MAST ARM	SF
823002	REPOSITION SIGN ON SPAN WIRE OR MAST ARM	EACH
823003	REMOVAL OF SIGN ON SPAN WIRE OR MAST ARM	EACH

SECTION 824 — DELINEATORS

824.1 Description.

This work consists of providing, installing, relocating, maintaining, and replacing high-performance flexible plastic, post-mounted delineation devices, or delineators mounted on posts or barriers.

824.2 Materials.

A. Delineators Section 1073

824.3 Construction.

A. High Performance Flexible Plastic Tubular Markers.

1. Provide and place high performance flexible plastic tubular markers meeting the requirements of the DE MUTCD, and in accordance with the Contract.
2. Remove loose debris from the road surface in the application area.
3. Install and anchor delineators on dry asphalt or concrete surfaces in accordance with the manufacturer's instructions. Ensure that the installation method allows for easy replacement of future damaged delineators.
4. Replace damaged delineators within 24-hours of notification by the engineer.

B. Post-Mounted Delineators.

1. Provide post-mounted delineators meeting the requirements of the DE MUTCD and the Standard Construction Details, and in accordance with the contract.
2. Submit 2 samples each of the posts, brackets, connecting devices, and driving heads complete with reflector units.
3. Ship materials to the construction site only after submission of samples and written approval of the samples from the engineer.
4. Include steel posts and each color of delineator planned for use.
5. Whenever delineators require special keys, wrenches, or locking instruments to remove, place, maintain, or repair, provide the specialty tools to the engineer. Provide 1 special key, wrench, or locking instrument for each 500 delineators or a portion of 500 delineators.
6. Install post mounted delineators in accordance with the manufacturer's instructions.
7. Replace damaged delineators within 24-hours of notification by the engineer.

C. Barrier Mounted Delineators.

1. Install high impact barrier mounted delineators onto permanent PCC barrier.
2. Space the delineators longitudinally in accordance with the DE MUTCD.
3. Install delineators at a height of 29-inches, measured from the roadway surface to the top of the delineator.
4. Attach delineators to the traffic side of the PCC barrier wall face in accordance with the manufacturer's instructions.
5. Replace damaged delineators within 24-hours of notification by the engineer.

D. Flexible Delineators

1. Place flexible delineators as indicated in the contract.

2. Install flexible delineators in accordance with manufacturer recommendations to a final top elevation of no less than 36-inches as measured from the ground surface elevation.

   a. Do not install delineators in frozen ground.

3. Affix vertical lettering to the top portion of the flexible delineator in accordance with the contract.

824.4 Method of Measurement.

The Department will measure the quantity of delineators as the number of delineators installed and accepted.

824.5 Basis of Payment.

A. The Department will pay the quantity of delineators at the contract unit price per each. Price and payment constitute full compensation for providing and installing delineators.

B. The Department will pay for replacement of each damaged delineator at the contract unit bid price after the engineer verifies the replaced quantity. Price and payment constitute full compensation for removing damaged delineators and providing and installing new delineators.

ITEM	DESCRIPTION	UNIT
824001	BARRIER MOUNTED DELINEATOR	EACH
824002	POST MOUNTED DELINEATORS	EACH
824003	FLEXIBLE DELINEATORS	EACH
824005	TUBULAR MARKER , WHITE, 28”	EACH
824006	TUBULAR MARKER , WHITE, 36”	EACH
824007	TUBULAR MARKER , YELLOW, 28”	EACH
824008	TUBULAR MARKER , YELLOW, 36”	EACH
824009	TUBULAR MARKER , ORANGE, 28”	EACH
824010	TUBULAR MARKER , ORANGE, 36”	EACH

SECTION 826 — PERMANENT WOOD BARRICADE

826.1 Description.

This work consists of providing, constructing, and placing pressure treated wood barricades.

826.2 Materials.

A.	Wood	Section 621; Section 1041
B.	Sign Panels	Section 818
C.	Galvanized Hardware	Section 1041.5

826.3 Construction.

A. Fabricate permanent barricade using No. 1 common yellow pine or fir Surfaced 4 Sides (S4S), in accordance with the DE MUTCD and the contract.

B. Treat sides, bottoms, and tops of the wood posts and rails with a preservative treatment in accordance with Section 1041.

C. Install retroreflective sheeting and sign panels with a minimum sheet panel thickness of 1/8-inch for the object markers in accordance with the DE MUTCD and the contract.

D. Excavate post holes.

E. Place posts into the excavated holes in accordance with the contract.

F. Backfill as necessary and dispose of unneeded material in accordance with Section 106.8.

G. Grade area as required by the engineer.

826.4 Method of Measurement.

The Department will measure the quantity of permanent wood barricades as the number of permanent wood barricades fabricated, placed, and accepted.

826.5 Basis of Payment.

A. The Department will pay the quantity of permanent wood barricades at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing and placing all materials;
2. reflective sheeting;
3. sheet aluminum sign panels;
4. preservative treatment; and
5. excavating and backfilling.

B. The Department considers sign panels for the permanent wood barricade and object markers as incidental to this item.

ITEM	DESCRIPTION	UNIT
826001	PERMANENT WOOD BARRICADE	EA

SECTION 830 — CONDUIT JUNCTION WELLS

830.1 Description.

This work consists of providing, constructing, installing, adjusting, relocating, and removing conduit junction wells and spare frames and lids or precast polymer concrete covers.

830.2 Materials.

A. Conduit Junction Well, Types 1, 4, and 5

1. Frames — Section 1039.7
2. Lids — Section 1039.7
3. Delaware stone No. 57 — Section 1004
4. Precast concrete, Class B — Section 1022
5. Castings with "DOT-E" logo on cover — Section 1039

B. Conduit Junction Well, Type 7

1. Precast polymer concrete stackable box with no base.
2. Delaware stone No. 57 — Section 1004
3. Precast polymer concrete.
   a. Heavy-weave fiberglass reinforcement.
   b. Compressive strength of 9,000 – 15,000 PSI.
   c. Impact energy of 30-72 foot-pounds.
   d. Tensile strength of 800 – 1,100 PSI.
   e. Tested in accordance with ASTM D543, Section 7, Procedure One for chemical resistance.
4. Precast polymer concrete traffic 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 "DelDOT TRAFFIC FIBER OPTICS" logo on cover

C. Borrow, Type C — Section 1001

830.3 Construction.

A. Conduit Junction Well.

1. Excavate to the required depth in accordance with Section 207.3. Construct a stone base for the junction well. Compact the foundation to a firm, even surface.
2. Place the conduit junction well.
3. Place the cast iron frame and lid or polymer concrete box cover.
4. Set level with the surrounding surface when placed in asphalt or concrete surfaces.
5. Set above grade when placed in areas not surfaced in asphalt or concrete. Grade to drain away from the junction well.

6. Backfill the area around the well with Borrow Type C material in accordance with Section 207. Dispose of excess or unsuitable material in accordance with Section 106.8.
7. Ground and bond the junction well in accordance with Section 833.

B. Adjusting or Repairing Existing Conduit Junction Wells.

1. Adjust the frame and lid to match the grade of the surrounding area, if surfaced with asphalt or concrete.
2. Repair and patch the masonry walls. Replace damaged or missing frames and lids or precast polymer concrete covers.

C. Relocating Existing Junction Wells.

1. Relocate existing junction wells to clear utilities or other construction work, in accordance with the contract.
2. Expose the conduit connected to the junction well in order to move the conduit with the well. Expose enough conduit to allow for movement without placing stress on the conduit or the conduit couplings.
3. Backfill and tamp, in accordance with Section 207.

D. Removing Existing Junction Wells.

1. Remove existing junction well, frame, and lid, or precast polymer concrete cover. Salvage JW type lids and frames, if possible, for reuse.
2. Abandon and cap or connect the existing conduits in the junction well in accordance with the contract.
3. Backfill with Type C borrow in accordance with Section 207.
4. Grade area to drain.
5. Place topsoil a minimum of 6-inches thick.
6. Seed in accordance with Section 908.

E. Junction well frames and lids or precast polymer concrete covers.

1. Provide new, or remove and reuse, cast iron frames, lids, or precast polymer concrete covers for new and existing junction wells, in accordance with the contract.

830.4 Method of Measurement.

A. The Department will measure the quantity of:

1. New junction wells as the number of conduit junction wells provided, placed, and accepted, including frames and lids or precast polymer concrete covers and stone base.
2. Relocated conduit junction wells as the number of conduit junction wells relocated and accepted.
3. Existing junction well removals as the number of conduit junction wells removed. The Department will consider excavation, backfill material, and backfilling as included in the bid item.
4. Spare junction well frames and lids or precast polymer concrete covers as the number supplied and delivered to the Department or project site and accepted.

830.5 Basis of Payment.

A. The Department will pay the quantity of new conduit junction wells placed and accepted at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing wells;
2. excavating;
3. placing;
4. stone base;
5. installing wells;
6. providing and placing frames and lids;
7. backfill and backfilling; and
8. grounding and bonding new junction well in accordance with Section 833.

B. The Department will pay for extending conduit into the junction well in accordance with Section 831.

C. The Department will pay the quantity of adjusted or repaired existing conduit junction wells at the contract unit price per each. Price and payment constitute full compensation for adjusting or repairing existing junction wells and for new frames and lids or precast polymer concrete covers.

D. The Department will pay the quantity of relocated or removed conduit junction wells at the contract unit price per each. Price and payment constitute full compensation for:

1. Excavating and backfilling to relocate existing junction wells;
2. backfill and backfilling;
3. removing existing junction wells; and
4. capping, plugging, or connecting existing conduits.

E. The Department will pay for removing existing conduit and cables and installing new connecting conduit and cables to the relocated well in accordance with Sections 831 and 832.

F. The Department will pay the quantity of junction well frames and lids or precast polymer concrete covers provided and installed at the contract unit price per each. Price and payment constitute full compensation for providing frames and lids or precast polymer concrete covers, delivery to the Department or project site, and installation as required by the engineer.

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
830008	ADJUST OR REPAIR EXISTING CONDUIT JUNCTION WELL	EACH
830009	RELOCATION OF EXISTING JUNCTION WELL	EACH
830010	REMOVAL OF EXISTING JUNCTION WELL	EACH
830011	PROVIDE AND INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 1	EACH
830012	PROVIDE AND INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 4	EACH
830013	PROVIDE AND INSTALL FRAME AND LID FOR JUNCTION WELL, TYPE 5	EACH

830015	PROVIDE AND INSTALL PRECAST POLYMER COVER FOR JUNCTION WELL, TYPE 7	EACH

SECTION 831 — CONDUIT

831.1 Description.

This work consists of providing and placing or removing conduit.

831.2 Materials.

A.	Conduit	
	1. Galvanized steel conduit	Section 1062
	2. High Density Polyethylene (HDPE) conduit	Section 1062
	3. Polyvinyl Chloride (PVC) conduit	Section 1062
	4. Flexible metallic-liquid tight conduit	Section 1062
	5. Nonmetallic belled end pole riser shield	Section 1062
B.	Conduit Hangers	Section 1062
C.	Pulling Rope	Section 1062
D.	Warning and Location Tape	Section 1062
E.	Conduit and Duct Sealant	Section 1062
F.	Borrow	Section 1001

831.3 Construction.

A. Install conduit in a straight line between terminal points whenever possible.

B. Space junction wells no more than 600-feet apart for fiber optic conduit.

C. Space junction wells no more than 250-feet apart for traffic signal and lighting conduit.

D. Use sweeping bends. Consult with the engineer before placing bends to obtain approval for the proposed conduit arc.

E. Apply conduit sealant to the exposed ends of lighting conduit in pole bases, cabinet bases, junction wells, and risers. Seal the conduit to provide a liquid tight connection. The Department will not require sealant for traffic signal or fiber optic conduit.

F. Provide a minimum cover of 24-inches and a maximum cover of 48-inches as measured from finished grade.

G. Place a pull rope or tape in each conduit if not already pre-installed by the manufacturer. Dispose of the pull rope after placing the cable in the conduit.

H. Use typical termination methods, for conduit not terminated to a base or junction well, as required by the Standard Construction Details. Do not extend conduit into a junction well any more than 3-inches.

I. 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

831.3.1 Galvanized Steel Conduit.

A. Cut, ream, and thread galvanized steel conduit using conduit tools.

B. Provide enough thread to ensure that the sections of conduits, when coupled together, will butt together providing a watertight joint.

C. Use an approved 3-piece threaded union to join 2 threaded lengths of galvanized steel conduit when a standard coupling will not work. Do not use a threaded union in a conduit run when placing conduit by the driven method. Do not use a threadless coupling or a split-bolt coupling for direct buried conduit.

831.3.2 HDPE-SDR 13.5 Conduit.

Connect lengths of HDPE conduit with irreversible fusion couplings. Do not use mechanical or removable couplings.

831.3.3 PVC Schedule 80 Conduit

A. Cut and prepare the conduit using conduit tools.

B. Connect lengths of PVC conduit by inserting the normal end of one length of conduit into the flared end of the adjoining length of conduit or use a coupling.

C. Seal all joints with epoxy to ensure that the 2 conduit pieces bond to one another to form a solid waterproof link.

D. Use a coupler module 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, if approved by the engineer. Place caps on the ends of conduits after using compressed air to clear debris from the conduit.

831.3.4 Directional Bore Installation.

A. Use the directional bore method to place conduit with a diameter of no less than 2-inches under the existing pavement. Do not exceed the outside diameter of the conduit being installed by more than 1-inch. Pump cement grout into the void in cases where the directional bore exceeds the outside diameter by more than 1-inch.

B. Upon completion of the directional boring operation and conduit placement, uncover the forward end of the conduit and use compressed air to clear debris before inspection.

831.3.5 Open Cut Installation.

A. Use the open cut installation method, when required by the contract, to place conduits with a diameter no less than 2-inches under existing pavement. Obtain the engineer's approval for open cutting roadways not shown as open cut in the contract. Remove cut pavement and replace the pavement after conduit installation.

B. Saw cut pavement in accordance with Section 762. Remove and dispose of cut pavement in accordance with Sections 401 or 503. Remove pavement in accordance with the Standard Construction Details. The engineer will decide if the excavated material is suitable or unsuitable for backfill. Provide new backfill material, if the engineer decides the excavated material is unsuitable for backfill. Excavate to a depth in accordance with Section 831.3 and the contract. Place conduit and spare conduit in the trench and terminate in a junction well or base, in accordance with the Standard Construction Details.

C. Place backfill material in level lifts of loose material, no greater than 8 inches. Compact the lifts in accordance with Section 207. Install underground warning tape over the conduit approximately 12-inches below the final grade. Compact the final lift of fill material to the planned final grade. Patch open trenches in accordance with Section 401 for bituminous pavements or Section 503 for rigid pavements.

831.3.6 Unpaved Trench Installation.

A. Excavate to a depth in accordance with Section 831.3 and the contract. Install conduit in the trench and terminate into a junction well or base in accordance with the Standard Construction Details.

B. Place backfill material in level lifts of loose material, no greater than 8 inches. Compact the lifts in accordance with Section 207. Install underground warning tape over the conduit approximately 12-inches below the final grade. Compact the final lift of fill material to the planned final grade. Apply topsoil and seed to the disturbed area in accordance with Section 908.

831.3.7 Conduit Installation on Structures.

Install conduit on structures, in accordance with the contract, using approved conduit hangers and anchors. Drill anchors into concrete, brick, stone, steel, or wood, and attach the conduit hangers, spaced no more than 36-inches apart. Use sweeping bends to provide 90-degree turns in the conduit run.

831.3.8 Pole Riser Shields.

Install nonmetallic pole riser shields on wood poles in a straight vertical line. Use an adapter if the nonmetallic pole riser is not the same size as the conduit the riser attaches to. Attach the riser shield to the pole with 1/4-inch x 1 1/2-inch galvanized lag bolts with washers. Install lag bolts spaced no more than 36 inches apart on both sides of the riser shield and in the topmost and bottom most set of slots.

831.3.9 Conduit Removal from Wood Poles.

Remove conduit, straps, nails, or lag screws in a manner that does not damage or disturb other conduits on the pole. Dispose of materials in accordance with Section 106.8.

831.4 Method of Measurement.

A. The Department will measure the quantity of galvanized steel, HDPE, PVC, or flexible metallic liquid tight conduit, and nonmetallic pole riser shields as the number of linear feet provided, placed, and accepted.

B. The Department will measure the length of conduit installed under existing pavement by directional bore along the path of the bore from the point where it is not possible to trench to a point where trenching can resume.

C. The Department will measure the length of conduit installed in open cut pavement, unpaved trench, on wood poles, and on structures along the conduit.

D. The Department will measure the quantity of conduit removed from a wood pole as the number of linear feet of conduit removed.

831.5 Basis of Payment.

A. The Department will pay the quantity of conduit provided and placed at the contract unit price per linear foot for the pay items listed below. Price and payment constitute full compensation for providing and placing conduit, backfill and backfilling, and duct sealant.

B. The Department will pay for topsoil and seeding in accordance with Section 908.

C. The Department will pay for restoring pavement in accordance with Sections 401 or 502.

D. The Department will pay for saw cutting in accordance with Section 762.

E. The Department will pay for the quantity of conduit removed from wood poles at the contract unit price per linear foot for the pay items listed below. Price and payment constitute full

compensation for removing conduits and attachment hardware and disposing of removed materials.

ITEM	DESCRIPTION	UNIT
831001	PROVIDE AND INSTALL UP TO 3” FLEXIBLE METALLIC-LIQUID TIGHT CONDUIT	LF
831002	PROVIDE AND INSTALL UP TO 4” SCHEDULE 80 HDPE CONDUIT (BORE)	LF
831003	PROVIDE AND INSTALL UP TO 4” SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831004	PROVIDE AND INSTALL UP TO 4” SCHEDULE 80 PVC CONDUIT (TRENCH)	LF
831005	PROVIDE AND INSTALL UP TO 4” SCHEDULE 80 PVC CONDUIT (ON STRUCTURE)	LF
831006	PROVIDE AND INSTALL UP TO 4” GALVANIZED STEEL CONDUIT (TRENCH)	LF
831007	PROVIDE AND INSTALL UP TO 4” GALVANIZED STEEL CONDUIT (BORE)	LF
831008	PROVIDE AND INSTALL UP TO 4” GALVANIZED STEEL CONDUIT (OPEN CUT)	LF
831009	PROVIDE AND INSTALL UP TO 4’ GALVANIZED STEEL CONDUIT (ON STRUCTURE)	LF
831010	PROVIDE AND INSTALL UP TO 4” NONMETALLIC POLE RISER SHIELD	LF
831011	REMOVAL OF CONDUIT FROM WOOD POLE	LF
831012	PROVIDE AND INSTALL UP TO 6” SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831013	PROVIDE AND INSTALL 4" SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831014	PROVIDE AND INSTALL 3" SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831015	PROVIDE AND INSTALL 2 1/2" SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831016	PROVIDE AND INSTALL 2" SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831017	PROVIDE AND INSTALL 1" SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831018	PROVIDE AND INSTALL 1” FLEXIBLE METALLIC LIQUIDTIGHT CONDUIT	LF
831019	PROVIDE AND INSTALL 2” FLEXIBLE METALLIC LIQUIDTIGHT CONDUIT	LF
831020	PROVIDE AND INSTALL 3” FLEXIBLE METALLIC LIQUIDTIGHT CONDUIT	LF
831021	PROVIDE AND INSTALL 4” FLEXIBLE METALLIC LIQUIDTIGHT CONDUIT	LF
831022	PROVIDE AND INSTALL 1" SCHEDULE 80 PVC CONDUIT (TRENCH)	LF
831023	PROVIDE AND INSTALL 2" SCHEDULE 80 PVC CONDUIT (TRENCH)	LF
831024	PROVIDE AND INSTALL 2 1/2" SCHEDULE 80 PVC CONDUIT (TRENCH)	LF
831025	PROVIDE AND INSTALL 3" SCHEDULE 80 PVC CONDUIT (TRENCH)	LF
831026	PROVIDE AND INSTALL 4" SCHEDULE 80 PVC CONDUIT (TRENCH)	LF
831027	PROVIDE AND INSTALL 1" SCHEDULE 80 PVC CONDUIT (ON STRUCTURE)	LF
831028	PROVIDE AND INSTALL 2" SCHEDULE 80 PVC CONDUIT (ON STRUCTURE)	LF
831029	PROVIDE AND INSTALL 2 1/2" SCHEDULE 80 PVC CONDUIT (ON STRUCTURE)	LF
831030	PROVIDE AND INSTALL 3" SCHEDULE 80 PVC CONDUIT (ON STRUCTURE)	LF
831031	PROVIDE AND INSTALL 4" SCHEDULE 80 PVC CONDUIT (ON STRUCTURE)	LF
831032	PROVIDE AND INSTALL 1” GALVANIZED STEEL CONDUIT (TRENCH)	LF
831033	PROVIDE AND INSTALL 2” GALVANIZED STEEL CONDUIT (TRENCH)	LF

ITEM	DESCRIPTION	UNIT
831034	PROVIDE AND INSTALL 2 1/2” GALVANIZED STEEL CONDUIT (TRENCH)	LF
831035	PROVIDE AND INSTALL 3” GALVANIZED STEEL CONDUIT (TRENCH)	LF
831036	PROVIDE AND INSTALL 4” GALVANIZED STEEL CONDUIT (TRENCH)	LF
831037	PROVIDE AND INSTALL 1” GALVANIZED STEEL CONDUIT (BORE)	LF
831038	PROVIDE AND INSTALL 2” GALVANIZED STEEL CONDUIT (BORE)	LF
831039	PROVIDE AND INSTALL 2 1/2” GALVANIZED STEEL CONDUIT (BORE)	LF
831040	PROVIDE AND INSTALL 3” GALVANIZED STEEL CONDUIT (BORE)	LF
831041	PROVIDE AND INSTALL 4” GALVANIZED STEEL CONDUIT (BORE)	LF
831042	PROVIDE AND INSTALL 1” GALVANIZED STEEL CONDUIT (OPEN CUT)	LF
831043	PROVIDE AND INSTALL 2” GALVANIZED STEEL CONDUIT (OPEN CUT)	LF
831044	PROVIDE AND INSTALL 2 1/2” GALVANIZED STEEL CONDUIT (OPEN CUT)	LF
831045	PROVIDE AND INSTALL 3” GALVANIZED STEEL CONDUIT (OPEN CUT)	LF
831046	PROVIDE AND INSTALL 4” GALVANIZED STEEL CONDUIT (OPEN CUT)	LF
831047	PROVIDE AND INSTALL 1” GALVANIZED STEEL CONDUIT (ON STRUCTURE)	LF
831048	PROVIDE AND INSTALL 2” GALVANIZED STEEL CONDUIT (ON STRUCTURE)	LF
831049	PROVIDE AND INSTALL 2 1/2” GALVANIZED STEEL CONDUIT (ON STRUCTURE)	LF
831050	PROVIDE AND INSTALL 3” GALVANIZED STEEL CONDUIT (ON STRUCTURE)	LF
831051	PROVIDE AND INSTALL 4” GALVANIZED STEEL CONDUIT (ON STRUCTURE)	LF
831052	PROVIDE AND INSTALL 2” HDPE SDR 13.5 CONDUIT (BORE)	LF
831053	PROVIDE AND INSTALL 2 1/2” HDPE SDR 13.5 CONDUIT (BORE)	LF
831054	PROVIDE AND INSTALL 3” HDPE SDR 13.5 CONDUIT (BORE)	LF
831055	PROVIDE AND INSTALL 4” HDPE SDR 13.5 CONDUIT (BORE)	LF
831056	PROVIDE AND INSTALL 1 1/2” SCHEDULE 80 PVC CONDUIT (OPEN CUT)	LF
831057	PROVIDE AND INSTALL 1 1/2” SCHEDULE 80 PVC CONDUIT (TRENCH)	LF
831058	PROVIDE AND INSTALL 1 1/2” SCHEDULE 80 PVC CONDUIT (ON STRUCTURE)	LF
831059	PROVIDE AND INSTALL 1 1/2” GALVANIZED STEEL CONDUIT (OPEN CUT)	LF
831060	PROVIDE AND INSTALL 1 1/2” GALVANIZED STEEL CONDUIT (TRENCH)	LF
831061	PROVIDE AND INSTALL 1 1/2” GALVANIZED STEEL CONDUIT (BORE)	LF
831062	PROVIDE AND INSTALL 1 1/2” GALVANIZED STEEL CONDUIT (ON STRUCTURE)	LF
831063	PROVIDE & INSTALL SECOND AND SUBSEQUENT ADDITIONAL 1" SCHEDULE 80 PVC CONDUITS IN TRENCH OR OPEN CUT	LF
831064	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 1 1/2" SCHEDULE 80 PVC CONDUITS IN TRENCH OR OPEN CUT	LF
831065	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 2" SCHEDULE 80 PVC CONDUITS IN TRENCH OR OPEN CUT	LF

ITEM	DESCRIPTION	UNIT
831066	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 2 1/2" SCHEDULE 80 PVC CONDUITS IN TRENCH OR OPEN CUT	LF
831067	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 3" SCHEDULE 80 PVC CONDUITS IN TRENCH OR OPEN CUT	LF
831068	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 4" SCHEDULE 80 PVC CONDUITS IN TRENCH OR OPEN CUT	LF
831069	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 2" HDPE 13.5 SDR CONDUIT IN DIRECTIONAL BORE	LF
831070	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 2 1/2" HDPE 13.5 SDR CONDUIT IN DIRECTIONAL BORE	LF
831071	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 3" HDPE 13.5 SDR CONDUIT IN DIRECTIONAL BORE	LF
831072	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 4" HDPE 13.5 SDR CONDUIT IN DIRECTIONAL BORE	LF
831073	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 1" GALVANIZED STEEL CONDUIT IN TRENCH OR OPEN CUT	LF
831074	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 1 1/2" GALVANIZED STEEL CONDUIT IN TRENCH OR OPEN CUT	LF
831075	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 2" GALVANIZED STEEL CONDUIT IN TRENCH OR OPEN CUT	LF
831076	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 2 1/2" GALVANIZED STEEL CONDUIT IN TRENCH OR OPEN CUT	LF
831077	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 3" GALVANIZED STEEL CONDUIT IN TRENCH OR OPEN CUT	LF
831078	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 4" GALVANIZED STEEL CONDUIT IN TRENCH OR OPEN CUT	LF
831079	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 1" STEEL CONDUIT IN DIRECTIONAL BORE	LF
831080	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 1 1/2" STEEL CONDUIT IN DIRECTIONAL BORE	LF
831081	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 2" STEEL CONDUIT IN DIRECTIONAL BORE	LF
831082	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 2 1/2" STEEL CONDUIT IN DIRECTIONAL BORE	LF
831083	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 3" STEEL CONDUIT IN DIRECTIONAL BORE	LF
831084	PROVIDE AND INSTALL SECOND AND SUBSEQUENT ADDITIONAL 4" STEEL CONDUIT IN DIRECTIONAL BORE	LF

SECTION 832 — ELECTRIC AND ITMS CABLE AND SPLICING

832.1 Description.

This work consists of providing, placing, splicing, and removing electrical or communication cable in conduit.

832.2 Materials.

A.	Electrical Cable and Wire	Section 1074.1
B.	Copper Conductor Cable	Section 1074.1
C.	Cable Splicing	Section 1074.2
D.	Breakaway Submersible Connector Kits	Section 1074.2

832.3 Construction.

A. General.

Transport and unreel electric cable from a cable trailer. Do not lay reels on the ground to remove wire or cable.

B. Pulling Cable or Wire Through Conduit, Mast Arms, Traffic Poles, Lighting Poles, Junction Wells, and Cabinet.

1. Manual Pulling.
   a. Required for conduit sizes of 1 1/2-inches or less.
   b. The Department prefers manual pulling for all other sizes. The Department will allow use of a mechanical puller if the engineer determines that manual pulling is not feasible.
2. A dynamometer is required when pulling cable or wire mechanically.
3. Use a short piece of material as a strain release element 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 pulls up through a 12 pair communications cable; and
   b. 300-pounds for larger cables.
4. The engineer may deem a cable or wire unacceptable if it is:
   a. Pulled into a conduit without the use of a 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 in excess of the 150-pound or 300-pound pulling limits.
5. Placing Cable or Wire in Existing Conduit.
   a. Use pulling lubricant recommended by the cable manufacturer.
   b. Pull cable or wire directly from reels into the conduit or pull the required length of cable fully off the reel and then pull into the conduit.

c. Arrange the cables in a straight lay to avoid damaging insulation and to avoid twists or kinks.

d. Protect the cable from moisture during placement.

e. Seal cable ends using rubber tape and paint with a sealing type of waterproof compound until final splicing.

6. Feed cables by hand into the conduit.

7. Use a sleeve when additional radius is required to prevent damage to the cable or wire.

8. Start underground cable runs at 1 terminal point, and continue without splices, to the final terminal point except for a home run cable to a loop detector wire.

   Do not splice emergency preemption cable in any application.

9. Leave and arrange additional cable and wire in a neat and orderly manner as follows:

   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 at splice locations.

10. In conduits with existing cables, provide a blunt terminal on the leading end of a fishing device to avoid damaging or entanglement with existing cables or wires. The Department will not allow bending or taping the end of the fishing device instead of using the blunt end terminal.

11. When pulling 2 or more cables into a conduit, pull cables in together, parallel to each other using a pulling head.

12. Wrap phase legs circumferentially and in sequence around the neutral wires.

13. Leave 2 feet of slack for lighting cables in lighting transformer base.

    For lighting cables, seal all conduit ends after cable placement in accordance with Section 831 - Conduit. Traffic signal conduits do not require duct sealant.

C. Overhead on Pole Span Wire.

1. Do not splice the electrical cable at the top of the pole. Continue the electrical cable onto the span wire to be taped.

2. Leave a drip loop in the electrical cable to prevent water from running along the cable and 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 tape at least 6 times around the span or cable wire every 12- inches to 14-inches.

5. Pull the electrical cable tight leaving no kinks.

6. Wrap the plastic tape tight around the span wire.

7. Leave a 36-inch long loop of signal cable at each signal head.

D. Splicing.

1. Traffic Control Cable and Single Conductor Stranded Wire.

a. Only splice underground traffic control cable where loop detector wire and the home-run cable meet. Do not splice cables in junction wells or conduits.

b. The Department will only allow traffic signal cable splices in pole hand-holes, transformer bases, or on span wire at the signal head.

c. Use rubber tape to seal the cable ends in control boxes and at all splice locations after cable placement pending splicing. Paint cable ends with a sealing type of waterproof compound.

d. Identify the circuit number of all cables and wires using color coded tape attached to each of the cables and wires in the control box and at all splicelocations.

e. Secure the color-coded tape to the cable or wire with nylon cable ties.

f. Redo faulty splices within 90 calendar days of installation.

g. Expose 1/2-inch of copper wire for splicing by removing the insulation.

h. Ensure that the copper conductor, in wires not planned for splicing, does not extend beyond the insulation.

i. Connect each conductor planned for splicing, then return all conductors (both used and unused) to their original configuration before the insulation was removed and then seal in accordance with Section 1074.

j. Do not allow individual cables to extend beyond the splice of the last signal head for each signal phase.

k. Splice shielded aluminum cable (home-run cable) with the loop detector wire in a junction well only. Do not splice the home-run cable outside of the junction well.

l. Overhead Wire.

   i. Place conductors planned for electrical connection side by side with the exposed copper aligned.

   ii. Twist the copper clockwise with pliers until a good mechanical connection is achieved.

   iii. Install and hand tighten a wire nut.

   iv. If necessary to cover all the copper, minor trimming is allowed.

   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.

m. Butt Splice Cable Termination.

   i. Remove the sheath of each cable as necessary.

   ii. Prepare the splice for taping after joining all conductors.

   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 2-inches over the intact sheath.

   v. Wrap the tape around the splice proceeding toward the other cable overlapping half of the tape width until reaching a point 2-inches on the other cable sheath.

   vi. Repeat taping in the other direction starting 1 tape width wider than the previous wrap.

vii. Increase overlapping where necessary to cover all areas of the splice.

viii. Place at least 4 layers of rubber tape, 2 fully overlapped passes deep for every area of the splice.

ix. Cover the rubber tape with plastic tape applied in the same fashion.

n. 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 planned for joining to the conductors of the branch cable.

iv. Do not cut any other conductors for any purpose.

v. Depending upon the need, the Department will allow placement of the branch cable beside 1 of the through cables. The Department will allow splicing of the through cable or doubling back of the through cable so that the parts of the through cable and the branch cable are placed side byside.

vi. Prepare the splice for taping after joining conductors.

vii. Place the cables in the approximate final position and inspect the cables for shorts.

viii. After positioning all wire nuts and wires, 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 and onto the sheath for a distance of 1-inch.

xi. Wrap the tape back from the end point on the branch cable back to the main cable.

xii. Tape the remaining part of the splice in the same manner.

xiii. Provide rubber tape at least 4 layers, 2 fully overlapped passes deep for every area of the splice.

xiv. Place the cables in the final position and tape with 2 fully overlapped passes of plastic tape in the same fashion.

xv. Do not use the plastic tape to cover the interior areas covered by the rubber tape.

xvi. Place the splice so that the branch cable enters the splice from below to prevent water from flowing along the branch cable into the splice area.

o. Cable Termination End.

i. Remove 3-inches of sheath from dead-ended cables.

Ii. Wrap each individual cable with rubber tape.

iii. Bundle and re-tape with vinyl tape.

iv. Coat with waterproofing compound.

p. Triplex Splice.

i. Remove sufficient insulation of the triplex service cable and other service cables to expose the conductor.

ii. Connect each of the 3 wires using 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. Apply compression type by means of a compression tool.

iii. Wrap compression connector in 2 layers of vinyl tape and 2 layers of rubber tape. Half-lap tape around connector.

3. Submersible, Breakaway Connector Kits in Lighting Transformer Bases.

Install connector kits in conformance with the manufacturer's recommendations.

E. Cable Removal.

1. Remove existing cable in accordance with plans.

2. Dispose of removed cable.

3. Conduit or steel pole.

a. Use hand pulling methods for conduit sizes of 1 1/2-inches or less. Hand pulling methods are preferred for all sizes of conduit.

b. Obtain the engineer's approval for using 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. The Department will consider electrical wire or cable damaged and will require replacement if the wire or cable is:

i. Pulled from any conduit without the use of an acceptable pulling grip, kellems, or equal.

ii. Pulled without the use of a strain release element.

iii. Pulled using methods that may, or did, result in pulling forces in excess of those set forth above or prescribed by industry standards.

e. Use only hand pulling methods for removal from steel pole.

i. Remove the weather head cover first.

ii. Remove the wire or cable by hand and replace the weather head cover.

f. Refer to the contract to see which electrical wires or communications cables to pull from each conduit or steel pole. The number of electrical wires or cables pulled from a conduit may exceed 1.

832.4 Method of Measurement.

A. Cable.

1. The Department will measure the quantity of cable as the number of linear feet of cable provided and pulled through conduits either underground, in mast arms, or in poles, or installed on a span wire, and accepted.
2. The Department will measure all required cable slack left at termination points or in junction wells as part of this item.

B. Conduit or Traffic or Lighting Pole Cable Removal.

1. The Department will 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.
2. The Department will consider pulling more than 1 wire, or a set of wires, as 1 cable, even if pulled 1 wire at a time.

832.5 Basis of Payment.

A. The Department will pay the quantity of cable provided and pulled through conduit or provided and placed on a span wire at the contract unit price per linear foot of the applicable pay item. Price and payment constitute full compensation for:

1. Material testing;
2. compression connectors;
3. breakaway connector and splice kits;
4 splicing; and
5. taping.

B. The Department will pay the quantity of cable removal from conduit or traffic and lighting poles at the contract unit price per linear foot of the applicable pay item. Price and payment constitute full compensation for all cable removal work.

C. The Department will not pay for existing electrical wire or cable as removal of cable or wire from conduits or poles when used as a fish wire to pull in new wire or cable.

ITEM	DESCRIPTION	UNIT
832001	PROVIDE AND INSTALL 1-CONDUCTOR #4/0 AWG STRANDED COPPER, TYPE USE-2	LF
832002	PROVIDE AND INSTALL 1-CONDUCTOR #3/0 AWG STRANDED COPPER, TYPE USE-2	LF
832003	PROVIDE AND INSTALL 1-CONDUCTOR #2/0 AWG STRANDED COPPER, TYPE USE-2	LF
832004	PROVIDE AND INSTALL 1-CONDUCTOR #1/0 AWG STRANDED COPPER, TYPE USE-2	LF
832005	PROVIDE AND INSTALL 1-CONDUCTOR #1 AWG STRANDED COPPER, TYPE USE-2	LF
832006	PROVIDE AND INSTALL 1-CONDUCTOR #2 AWG STRANDED COPPER, TYPE USE-2	LF
832007	PROVIDE AND INSTALL 1-CONDUCTOR #4 AWG STRANDED COPPER, TYPE USE-2	LF
832008	PROVIDE AND INSTALL 1-CONDUCTOR #6 AWG STRANDED COPPER, TYPE USE-2	LF
832009	PROVIDE AND INSTALL 1-CONDUCTOR #8 AWG STRANDED COPPER, TYPE USE-2	LF
832010	PROVIDE AND INSTALL 1-CONDUCTOR #10 AWG STRANDED COPPER, TYPE USE-2	LF

ITEM	DESCRIPTION	UNIT
832011	PROVIDE AND INSTALL 1-CONDUCTOR #10 AWG STRANDED COPPER, TYPE THWN OR THHN	LF
832012	PROVIDE AND INSTALL 1-CONDUCTOR #12 AWG STRANDED COPPER, TYPE THWN OR THHN	LF
832013	PROVIDE AND INSTALL 1-CONDUCTOR #14 AWG STRANDED COPPER, TYPE THWN OR THHN	LF
832014	PROVIDE AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#4/0 AWG	LF
832015	PROVIDE AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#2/0 AWG	LF
832016	PROVIDE AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#1/0 AWG	LF
832017	PROVIDE AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#2	LF
832018	PR AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#4 AWG	LF
832019	PROVIDE AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#6	LF
832020	PROVIDE AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#8 AWG	LF
832021	PROVIDE AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#10 AWG	LF
832022	PROVIDE AND INSTALL STRANDED INSULATED COPPER GROUND WIRE, 1/#12 AWG	LF
832023	PROVIDE AND INSTALL #12 AWG THWN SOLID COPPER	LF
832024	PROVIDE AND INSTALL #2 AWG BARE SOLID COPPER	LF
832025	PROVIDE AND INSTALL 4-CONDUCTOR #18 AWG SHIELDED OPTICOM CABLE	LF
832026	PROVIDE AND INSTALL 1-CONDUCTOR #14 AWG STRANDED COPPER	LF
832027	PROVIDE AND INSTALL 1-CONDUCTOR #14 AWG SHIELDED CABLE	LF
832028	PROVIDE AND INSTALL #6 BARE STRANDED COPPER GROUND WIRE	LF
832029	PROVIDE AND INSTALL #8/2 WIRE UF W/GROUND	LF
832030	PROVIDE AND INSTALL #8/3 WIRE UF W/GROUND	LF
832031	PROVIDE AND INSTALL #6 TRIPLEX ALUMINUM SERVICE CABLE	LF
832032	PROVIDE AND INSTALL 14/4 TRAFFIC CONTROL CABLE	LF
832033	PROVIDE AND INSTALL 14/9 TRAFFIC CONTROL CABLE	LF
832034	PROVIDE AND INSTALL 14/16 TRAFFIC CONTROL CABLE	LF
832035	REMOVAL OF CABLE FROM CONDUIT OR TRAFFIC/LIGHTING POLE	LF
832036	PROVIDE AND INSTALL 1-CONDUCTOR 125KCMIL STRANDED COPPER, TYPE USE-2	LF

SECTION 833 — GROUNDING

833.1 Description.

This work consists of providing and placing electrical grounding equipment.

833.2 Materials.

A. Stainless Steel Hardware Section 1039

B. Ground Rods

1. Underwriters Laboratories Approved.
2. 3/4-inch 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.

833.3 Construction.

Provide certified test reports verifying the ground resistance of each ground or ground grid when installed.

833.3.1 Ground Rods.

A. Provide and place ground rods with a minimum 3/4-inch diameter and 8-feet of embedment into undisturbed soil at the locations indicated in the contract. Measure the ground resistance of each rod before connecting the rod to the grounding conductor. Ensure that, if the measured resistance exceeds 25-ohms, in accordance with the National Electric Code, exothermically weld a 10-foot extension to the top of the first rod and drive to its full depth. Measure the earth resistance again. Contact the engineer for direction if the measured resistance still exceeds 25-ohms. Exothermically weld the ground rod and joining ground wire after successful testing. Paint the weld and exposed cable with 2 coats of insulating varnish.

B. The engineer may direct the use of a grounding grid where rock is encountered, and the contractor cannot achieve an acceptable earth ground by driving as described above. Exothermically weld direct buried rods end-to-end to bond lighting standards and structures in a continuous series to a point where the contractor can obtain an acceptable ground.

C. 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 in accordance with the contract. Make connections to neutral grounding systems using grounding lugs.

833.3.2 Bonding and Grounding Junction Well.

Drill holes in the junction well cover and the junction well frame. Attach a braided bonding strap to both the cover and frame in accordance with the contract to ensure proper bonding. Bond the junction well frame to the existing ground wire in the junction well, using a compression connector such as a C-tap.

833.4 Method of Measurement.

A. The Department will measure the number of 10-foot long lengths of ground rods as the number of ground rods provided, placed, and accepted. The Department will only measure ground rods separately that are replacements or are added as singular items. The Department will not measure ground rods installed in conjunction with pole bases, cabinet bases, or metered service pedestals as the ground rods are incidental to these items.

B. The Department will measure the number of existing junction wells grounded and bonded. The Department will not measure grounding and bonding of new junction wells as grounding and bonding are incidental to the applicable junction well pay item.

833.5 Basis of Payment.

A. The Department will pay for the items at the contract unit price per each. Price and payment constitute full compensation for providing and placing all materials.

ITEM	DESCRIPTION	UNIT
833001	BONDING AND GROUNDING EXISTING JUNCTION WELL	EA
833002	PROVIDE AND INSTALL GROUND ROD	EA

SECTION 834 — POLE BASES, EXTENSIONS, AND SHEETING

834.1 Description.

This work consists of constructing concrete pole bases, extensions, and sheeting.

834.2 Materials.

A. Pole Bases

1.	Ground rods	Section 833
2.	Self-Consolidating Concrete, Class B	Section 1022
3.	Bar reinforcement, Grade 60	Section 1037
4.	Conduit sweeps	Section 1062
5.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7

B. Pole Base Extensions

1.	Ground rods	Section 833
2.	Self-Consolidating Concrete, Class B	Section 1022
3.	Bar reinforcement, Grade 60	Section 1037
4.	Conduit sweeps	Section 1062
5.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7

C. Pole Base Sheeting

1.	Well-point system	Section 906
2.	Steel sheet piling	Section 1032
3.	Corrugated round steel tube as directed by the engineer	
4.	Sonotube as directed by the engineer	

D. Anchor Bolts Section 1039

834.3 Construction.

834.3.1 Pole Base.

A. The Department will measure the required depth of the pole hole as follows:

1. From the front of the pole base where the grade at the back of the pole is higher than the grade in front of the pole on slopes.
2. From the back of the pole when the grade on the back of the hole is lower than the front.

B. Do not exceed the diameter of the pole base during excavation. Construct pole base in accordance with the contract, including placement of anchor bolts, bar reinforcement, conduit sweep, and ground rod. Refer to the Standard Construction Details for the diameter and depth of pole bases for the types of pole bases shown in the contract. Place the concrete by tremie methods in accordance with Section 610.3.4.D.2 for placement depths greater than 5-feet from the point of

concrete discharge. Do not freefall concrete at distances greater than 5-feet. Cap the ends of the conduit sweeps with a galvanized threaded conduit plug. Cure exposed pole base surfaces in accordance with Section 501.3 with materials in accordance with Section 1022.6. After the concrete for the pole bases has cured, backfill the area around the pole base using approved material. Place and compact backfill material in accordance with Section 202. Apply topsoil and seed in the disturbed area, in accordance with Section 908.

C. Attach rodent screen to base plate foundation gap with galvanized steel screen,1/2-inch by 1/2-inch mesh and 0.0063-inch diameter wires. Screen is to be removable and attached to the base plate with stainless steel hardware.

834.3.2 Pole Base Extension.

A. Extend pole bases where the contract requires pole bases deeper than what is shown in the Standard Construction Details. Extend reinforcing bars in a pattern that complies with the Standard Construction Details and match the pattern of the extended pole base reinforcement bars using continuous vertical bars in accordance with Section 611.3.C. Form the pole base extension and pour concrete in accordance with Section 610. Backfill the excavated area in accordance with Section 202.

B. 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.

834.3.3 Pole Base Sheeting.

A. Install steel sheet piling, corrugated round steel tube, sonotube, or a well-point system when encountering soil conditions that prohibit the construction of a pole base using wood or plywood sheeting. Install pole base sheeting when directed by the engineer.

B. Construct pole base as specified in Section 834.3.1 after installing pole base sheeting. Extend the 2 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. Leave metal sheeting material in place and cutoff sheeting material at least 6-inches below the surface of the ground. Dispose of excavated material from the project site in accordance with Section 106.8.

834.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Pole bases as the number of pole bases placed and accepted.
2. Pole base extensions as the number of cubic feet of concrete required to increase the vertical dimension from the standard depth to the increased depth. The Department will measure the volume by multiplying the vertical increase in depth by the cross-sectional area of the standard pole base.
3. Pole base sheeting as the sheeting used for a pole base excavation provided, placed, and accepted. The Department considers sheeting used for 1 pole as a single unit. The Department will only pay for locations where the contractor has written permission to use sheeting.

834.5 Basis of Payment.

A. The Department will pay for the accepted quantities at the contract unit price.

B. The Department will pay the quantity of pole bases at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing, placing, and curing concrete;
2. bar reinforcement;
3. ground rod;
4. anchor bolts;
5. conduit sweeps;
6. excavating and backfilling; and
7. rodent screen.

C. The Department will pay the quantity of pole base extensions at the contract unit price per cubic feet for pole base extension. Price and payment constitute full compensation for:

1. Providing, placing, and curing concrete;
2. bar reinforcement;
3. ground rod;
4. excavating; and
5. backfilling.

D. The Department will pay the quantity of pole base sheeting at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing and placing material;
2. cutting off sheeting below grade; and
3. removing sheeting from the project site.

ITEM	DESCRIPTION	UNIT
834001	POLE BASE, TYPE 1	EACH
834002	POLE BASE, TYPE 2	EACH
834003	POLE BASE, TYPE 2A	EACH
834004	POLE BASE, TYPE 2B	EACH
834005	POLE BASE, TYPE 3	EACH
834006	POLE BASE, TYPE 3A	EACH
834007	POLE BASE, TYPE 3B	EACH
834008	POLE BASE, TYPE 3C	EACH
834009	POLE BASE, TYPE 4A	EACH
834010	POLE BASE, TYPE 4B	EACH
834011	POLE BASE, TYPE 6	EACH
834012	POLE BASE, TYPE 6B	EACH
834013	POLE BASE EXTENSION	CF

8340014	SHEETING FOR POLE BASE	EACH

SECTION 835 — CABINET BASES

835.1 Description.

This work consists of constructing cabinet bases.

835.2 Materials.

A.	Ground Rods and Clamps	Section 833
B.	Delaware Stone, No. 57	Section 1004
C.	PCC, Class B	Section 1022
D.	Liquid Membrane-Forming Compounds for Curing	Section 1045.7
E.	Hex Bolts, Stainless Steel	Section 1039
F.	Drop-in Anchors, Zinc Plated or Stainless-Steel	Section 1039
	Manufactured by Hilti systems, concrete fastening systems, or approved equal	
G.	Conduit Sweeps, PVC Schedule 80	Section 1062

835.3 Construction.

A. Construct cabinet base in accordance with the contract.

1. When excavating the area for the cabinet base, do not exceed the dimension of the base foundation by more than 12-inches in any direction.
2. When placing a base in existing concrete pavement or sidewalk, saw cut the concrete in a square pattern or remove the concrete to the nearest joint.
3. Stockpile excavated material on the site until completion of backfilling.
4. Place the cabinet base stone to a depth of 6-inches or as directed by the engineer.
5. Excavate additional space for the required concrete apron and place stone in the extended area when placing the base in an unpaved area.
6. Set the ground rod as shown in accordance with the Standard Construction Details and in accordance with Section 833. Drive the ground rod a minimum of 8 feet into soil through a 2-inch PVC sleeve.

B. Set conduit sweeps as shown in the contract.

1. Drive the PVC sleeve for the ground rod into the ground so that the top of the sleeve is 2-inches above the base concrete when poured.
2. Place forms to the full depth for the base and install conduit sweeps in accordance with the Standard Construction Details.
3. Use conduit 90-degree sweeps with elbows having a 24-inch radius.
4. Leave a minimum of 2-inches and a maximum of 4-inches of conduit exposed above finished pad grade.
5. Connect conduit sweeps to the existing conduit in accordance with the contract. Cap unused conduit sweeps with tape. Mark the direction of the conduit run the sweep is connected to on the base with arrows drawn in the wet concrete within 6-inches of outer edge of the base.

C. Pour concrete for cabinet base and any required concrete aprons. Set drop-in anchors. Level, edge, and broom finish. Cure exposed concrete surface with materials in accordance with Section 1022.6. Remove forms and conduit plugs after setting for 2 calendar days. Backfill around the cabinet base and dispose of excess material. Fill and tamp the area between the form and excavated area on all sides.

835.4 Method of Measurement.

The Department will measure the quantity of cabinet bases as the number of bases placed and accepted.

835.5 Basis of Payment.

A. The Department will pay the accepted quantities of cabinet bases constructed and accepted at the contract unit price per each. Price and payment constitutes full compensation for:

1. Providing and placing all materials;
2. curing and finishing concrete;
3. conduits extending into the cabinet base; and
4. removing or replacing pavement underneath the cabinet base.

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

SECTION 836 — TRAFFIC SIGNAL POLES AND MAST ARMS

836.1 Description.

This work consists of installing, relocating, or removing steel poles, pedestal poles, and mast arm assemblies on existing pole bases.

836.2 Materials.

A. The Department will provide steel mast arms, steel poles, pedestal poles, and all necessary hardware, unless otherwise indicated in the contract.

B. Where pole relocation is part of the contract, re-use the existing pole and hardware, unless otherwise indicated in the contract.

C. Non-Shrink Grout Section 1047.2

836.3 Construction.

836.3.1 Installation.

A. Notify the engineer 2 working days in advance to obtain the materials from the Department. Pick up the materials at the DelDOT Sign Shop.

B. Assemble steel poles and mast arms. Before erecting a pole, ensure that the anchor bolt is revealed per the manufacturer's specifications and Standard Construction Details. Notify the engineer if the existing anchor bolts do not meet this criteria and wait for instructions. Do not erect the pole until directed.

C. Identify aerial utilities within the area and coordinate the work with the owner of the utility. Install poles at least 10-feet below or 10-feet away from primary electric cables.

D. Remove conduit caps or knockouts from the conduit that extend from the pole base.

E. Install insulated grounding bushings.

1. 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.
2. Continue the #6 AWG copper ground wire, on multi-section steel camera poles, 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.
3. Do not install or temporarily place the #6 AWG copper ground wire between the leveling nut and the pole.

F. Raise steel pole or pedestal pole into position.

1. Place pole on the anchor bolts. Hold the pole in place until completing installation and tightening of the anchor bolt the nuts.
2. Use a nut under the base of the pole and a nut above the base of the pole on all steel pole installations.
3. Adjust and tighten the anchor bolt nuts once the pole is set, to position the pole in accordance with the contract.
4. Connect the ground wire.

5. Place the shroud or skirt or pedestal poles around the pole in accordance with the manufacturer's instructions.
6. Attach mast arms to poles in accordance with the mast arm manufacturer's requirements. Wrap the area between the base of the pole and pole skirt and the top of the foundation with a stainless steel rodent screen as indicated in Section 834.3.1. Place the anchor bolt covers and the hand hole cover on the pole. Place caps at the top of the poles and at the ends of the mast arms.

836.3.2 Pole Removal.

A. Disconnect, detach, and remove electrical equipment and from the pole.

B. Stabilize the pole and remove the top nuts.

C. Remove the pole with related hardware assemblies from the pole base.

D. Store the pole and related hardware within the project limits for transportation later to a new or reused pole base.

E. Clean the grout or other materials off the top of the pole base if the pole base is planned for reuse. Cap the conduit using a conduit plug. Do not cap conduits with tape. If the pole base is not immediately reused, place protection around the pole base to prevent pedestrian injury.

836.4 Method of Measurement.

A. The Department will measure the quantity of placed poles as the number of poles placed and accepted.

B. The Department will measure the quantity of removed poles as the number of poles removed.

836.5 Basis of Payment.

A. The Department will pay the quantity of poles installed at the contract unit price per each pole. Price and payment constitute full compensation for transporting and setting the poles.

B. The Department will pay the quantity of poles removed at the contract unit price per each pole. Price and payment constitute full compensation for removing and transporting poles with hardware and pedestals.

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

837.1 Description.

This work consists of providing, assembling, and installing light emitting diode (LED) traffic signal and pedestrian signal indications.

837.2 Materials.

A. Traffic Signal Heads	Section 1075
B. Rectangular Rapid Flashing Beacon (RRFB) Unit:	
1. RRFB Indication	Section 1075
2. Signs	Section 818
3. LED Pedestrian Pushbutton Assembly	Section 1075

837.3 Construction.

A. This specification refers to definitions and practices described in the following ITE documents:

1. "Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement" dated June 27, 2005 and referred to in this document as VTCSH-LED.
2. "Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Vehicular Arrow Traffic Signal Supplement" dated January 2008 and referred to in this document as VTCSH-ARROW.
3. "Equipment and Material Standards of the ITE" dated November 1998 and referred to in this document as VTCSH.

837.3.1 Rigid Mount Signal Head Section.

A. Provide, assemble, and install rigid mounted LED signal heads, housings, and visors in accordance with the contract.

B. Perform wiring and electrical connections to make the signal head functional.

C. Provide a minimum of a 6 section, 12 position terminal block, capable of accepting 3 number 14 AWG spade terminal ends for each single or double section, and the middle section of a 3 section signal head assembly.

D. Install rigid mount signal assemblies on steel poles. The Department will allow placement of rigid mount signal assemblies on wood poles for temporary signal installations. Refer to the contract for the mounting types including top, side, and rigid.

E. Place signal cable down the pole and into the cabinet base. Run the cable without splicing from inside the signal head to the base of the pole and provide 5-feet of slack for connection.

837.3.2 Span Mount Signal Head Section.

A. Provide, assemble, and install span mounted LED signal heads, housings, and visors in accordance with the contract.

B. Perform wiring and electrical connections to make the signal head functional.

C. Provide a minimum of a 6 section, 12 position terminal block, capable of accepting 3 number 14 AWG spade terminal ends for each single or double section, and the middle section of a section signal head assembly.

D. Place signal cable along the span, down the pole, and connect into the base. Run the cable without splicing from inside the signal head to the base of the pole and provide 5-feet of slack for connection.

837.3.3 LED Traffic Signal Head Indication Module.

A. Remove existing LED traffic signal head indication modules and provide and install new LED traffic signal head indication modules in existing signal heads. Use only replacement modules compatible with the housing of the existing module.

B. Perform wiring and electrical connections to make the signal head functional.

837.3.4 Signal Head Backplate.

A. Provide and install backplates in accordance with the contract.

B. Fabricate backplates as shown on the applicable detail sheet to match the required signal configuration.

837.3.5 16 Inch LED Countdown Pedestrian Signal.

A. Provide, assemble, and install LED countdown pedestrian signal heads, visors, and housings in accordance with the contract.

B. Perform wiring and electrical connections to make the pedestrian signal assembly functional.

C. Provide and install components and hardware listed in Section 837.2 and in the Standard Construction Details in accordance with the contract.

D. Place cable down the pedestal or pole and connect in the base. Run the cable without splicing from inside the pedestrian signal head to the base of the pole and provide an additional 5-feet for connection.

E. Inspect each sign location to determine if clearing is required to maintain sight lines. Clear in accordance with Section 201 and as directed by the engineer.

837.3.6 LED Pedestrian Signal Head Indication 16 Inch Module.

A. Remove existing LED pedestrian signal head modules.

B. Provide and install new LED pedestrian signal head modules in existing pedestrian signal heads. Use only replacement modules compatible with the housing of the existing module.

C. Perform wiring and electrical connections to make the pedestrian signal head functional.

D. Inspect each sign location to determine if clearing is required to maintain sight lines. Clear in accordance with Section 201 and as directed by the engineer.

837.3.7 Pedestrian Pushbutton on Steel Pole with Sign.

A. Drill a 1/2-inch diameter hole in the steel pole at a height and location in accordance with the contract. Align the cable entrance hole in the pushbutton device with the 1/2-inch diameter hole in the pole.

B. Drill and tap the steel pole for the 2 mounting bolts, using the pushbutton housing as a template. Install the pushbutton housing using 1/4-inch x 1-inch bolts.

C. Wire the pushbutton and install on the pushbutton housing with a type and size of cable in accordance with the contract. Run the cable without splicing from inside the pedestrian pushbutton to the base of the pole and provide an additional 5-feet for connection.

D. Install the sign supplied by the Department in accordance with the contract.

837.3.8 Rectangular Rapid Flashing Beacon (RRFB) Unit.

A. Provide, assemble, and install rectangular rapid flashing beacons (RRFBs), mounts, bracket, and hardware in accordance with the contract.

B. Perform wiring and electrical connections to make the RRFB assembly functional.

C. Provide and install components and hardware listed in Section 837.2 and in the Standard Construction Details in accordance with the contract.

D. Place cable down the pedestal or pole and connect in the base. Run the cable without splicing from inside the pedestrian signal head to the base of the pole and provide an additional 5-feet for connection.

837.3.9 Realign or Slide Existing Signal Head.

A. For span wire installations, loosen saddle bolts, slide the existing signal head to a specified location on the span wire, and re-tighten the bolts. Loosen the 2 set screws on the top side of the head and the large nut inside the door of the top section to realign span mounted signal heads. Re-tighten nut and set screws after completing realignment.

B. Loosen the mounting band brackets for mast arm installations and adjust in accordance with the manufacturer's instructions. Slide the signal head into the new position and re-tighten the mounting band brackets. Loosen hardware to realign mast arm mounted signal heads, and realign head and re-tighten hardware, in accordance with the manufacturer's instructions.

837.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Signal head sections as the number of signal head sections provided, assembled, installed, and accepted. For example, a 1-way 3-section signal assembly would constitute 3 pay units.
2. LED traffic signal head indication modules as the number of modules provided, installed in an existing signal head, and accepted.
3. Signal head backplates as the number of complete signal head backplate assemblies provided, assembled, installed, and accepted.
4. LED countdown pedestrian signals as the number of LED countdown pedestrian signals provided, assembled, installed, and accepted.
5. LED pedestrian signal head indications as the number of pedestrian signal head indications provided and installed in an existing pedestrian signal housing and accepted.
6. Pedestrian pushbuttons with signs as the number of pedestrian pushbuttons provided, assembled, installed, and accepted.
7. Existing signal heads realigned or slid as the number of existing realigned or slid signal heads accepted.
8. RRFB units as the number of each unit provided, assembled, installed, and accepted.

837.5 Basis of Payment.

A. The Department will pay the quantity of signal head sections provided, installed, and accepted at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing and installing the signal head section;
2. housing, wiring, electrical connection, visors;
3. providing and installing the LED traffic signal head module; and
4. rigid mounting or span mounting and related hardware to provide a functioning signal assembly.

B. The Department will pay the quantity of LED traffic signal head indication modules provided, installed, and accepted in existing signal heads at the contract unit price per each. Price and payment constitute full compensation for providing and installing the LED traffic signal head indication in an existing signal head and removing and disposing of the existing LED module. The Department will consider removal and disposal of the replaced modules as incidental to the item.

C. The Department will pay the quantity of signal head backplates provided, assembled, installed, and accepted at the contract unit price per each. Price and payment constitute full compensation for providing, assembling, and installing the signal head backplate and retroreflective border.

D. The Department will pay the quantity of LED countdown pedestrian signals provided, assembled, installed, and accepted at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing and installing the assembly;
2. housing;
3. wiring;
4. electrical connections;
5. visors;
6. mounting; and
7. related hardware to provide a functioning pedestrian signal.
8. The Department will pay for clearing and grubbing in accordance with Section 201. If the Bid Proposal does not include 201000, this Work will be incidental to the pedestrian signal item.

E. The Department will pay the quantity of LED pedestrian signal head indication modules installed and accepted in existing pedestrian signal housings at the contract unit price per each. Price and payment constitute full compensation for providing and installing the LED pedestrian signal head module in an existing pedestrian signal housing and removing and disposing of the existing LED module. The Department will consider removal and disposal of the replaced modules as incidental to the item.

1. The Department will pay for clearing and grubbing in accordance with Section 201. If the Bid Proposal does not include 201000, this Work will be incidental to the pedestrian signal item.

F. The Department will pay the quantity of pedestrian pushbutton assemblies installed and accepted at the contract unit price per each. Price and payment constitute full compensation for:

1. Providing, assembling, and installing the pushbutton assembly;
2. wiring;
3. electrical connection;
4. sign installation;
5. mounting; and

6. related hardware to provide a functioning pedestrian pushbutton.

G. The Department will consider the cost of control equipment necessary for the pushbutton assemblies to operate as included in the unit price for the pushbutton assembly.

H. The Department will pay the quantity of existing signal heads, realigned or slid, and accepted at the contract unit price per each.

I. The Department will pay for RRFB units at the contract unit price per each. Price and payment constitute full compensation for:
   1. Providing, assembling, and installing the unit;
   3. supplying cable;
   4. electrical connections;
   5. and mounting the unit.

ITEM	DESCRIPTION	UNIT
837001	PROVIDE AND INSTALL 8” LED SIGNAL HEAD SECTION, RIGID MOUNT	EACH
837002	PROVIDE AND INSTALL 12” LED SIGNAL HEAD SECTION, RIGID MOUNT	EACH
837003	PROVIDE AND INSTALL 8” LED SIGNAL HEAD SECTION, SPAN MOUNT	EACH
837004	PROVIDE AND INSTALL 12” LED SIGNAL HEAD SECTION, SPAN MOUNT	EACH
837005	PROVIDE AND INSTALL 8” LED TRAFFIC SIGNAL HEAD INDICATION MODULE	EACH
837006	PROVIDE AND INSTALL 12” LED TRAFFIC SIGNAL HEAD INDICATION MODULE	EACH
837007	PROVIDE AND INSTALL SIGNAL HEAD BACKPLATE	EACH
837008	PROVIDE AND INSTALL 16” LED COUNTDOWN PEDESTRIAN SIGNAL	EACH
837009	PROVIDE AND INSTALL 16” LED PEDESTRIAN SIGNAL HEAD INDICATION MODULE	EACH
837010	PROVIDE AND INSTALL PEDESTRIAN PUSHBUTTON WITH SIGN	EACH
837011	REALIGN OR SLIDE EXISTING SIGNAL HEAD	EACH
837012	PROVIDE AND INSTALL RECTANGULAR RAPID FLASHING BEACON (SINGLE)	EACH
837013	PROVIDE AND INSTALL RECTANGULAR RAPID FLASHING BEACON (DOUBLE)	EACH

SECTION 838 — SPAN WIRE AND MESSENGER WIRE

838.1 Description.

This work consists of providing, placing, transferring, adjusting, relocating, or removing span wire, messenger wire, and associated attachments.

838.2 Materials.

A. Span Wire and Messenger Wire Section 1076

838.3 Construction.

838.3.1 Span Wire.

A. Provide and install span wire on steel or wood poles in accordance with the contract. The engineer will specify the tension of the installed span wire and the attachment height. Apply tension to the span wire using a tensioning device with a minimum capacity of 6,000-pounds pull.

B. For span wire between wood poles, prepare the poles as follows:

1. Install 2 strain plates on each pole, 1 on the side facing traffic and 1 on the opposite side away from traffic, in accordance with the Standard Construction Details.
2. Install 2 guy hooks on each pole, 1 on the side facing traffic and 1 on the opposite side away from traffic, in accordance with the Standard Construction Details.

C. Place span wire in accordance with applicable electrical and safety codes. Install strain insulators based on field conditions and as directed by the engineer. Equip each span with 2 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.

D. Attach span wire to the poles and strain insulators in the following manner:

1. Wrap the span wire, starting at the pole nearest the strain insulator, 1.5 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 2 galvanized guy clamps on the span wire end-to-end. Place one 2 1/5-feet from the pole and place the second clamp 1-inch away from the first.
3. Extend the end of the span wire at least 3-feet from the last clamp and secure the span wire with a service sleeve.
4. Place a strain insulator by doubling back the span wire through the hole in the insulator. Attach the doubled back span wire to the other span wire using 2 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 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 to achieve the tension in accordance with the contract. 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 secure the span wire with a service sleeve.

838.3.2 Dead End Messenger Wire Attachment.

A. The engineer shall specify the tension of the messenger wire in the dead-end attachment.

B. Wood Poles.

1. Drill a hole through the wood pole at the height specified by the engineer and install an eyebolt with washers on each end.
2. If the engineer determines that a down guy assembly is required, install a down guy attachment on the back of the pole instead 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.

C. Steel Poles.

1. Wrap the messenger wire around the steel pole 1.5 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 2 galvanized clamps on the messenger wire end, in accordance with the Standard Construction Details.
2. Extend the end of the messenger wire at least 3-feet from the last clamp and secure the messenger wire with a service sleeve.

838.3.3 Intermediate Messenger Wire Attachment.

A. Wood Poles Only.

1. Install a straight run intermediate messenger wire attachment as follows:
   a. Tension the messenger wire as directed by the engineer, then fit the proper clamp over the messenger wire and tighten the outside 2 clamp bolts.
   b. Drill a hole through the pole at the height specified by the engineer.
   c. Install a machine bolt through the center bolt hole of the clamp, the guy hook, the pole, and the washer. Tighten with a nut. Install a second nut as a lock nut.
   d. 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 #6 AWG solid copper wire between the parallel groove connector and the split-bolt connector and tighten all hardware.

B. Install an angular run intermediate messenger wire attachment as follows:

1. Drill a hole through the pole at the height specified by the engineer.
2. Install an eyebolt through the washer, the pole, and the back washer. Install a guy attachment on the back of the pole instead of the back washer, if a down guy assembly is shown in the plans or directed to be installed by the engineer. 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. Attach the 2 service wedge clamps and the messenger wire to the eyebolt assembly, as shown in the contract.
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 #6 AWG solid copper wire between the parallel groove connector and the split-bolt connector and tighten all hardware.

838.3.4 Adjusting Span or Messenger Wire.

A. Adjust existing span or messenger wire including tightening, raising and tightening, loosening, or other work, only as directed by the engineer.

B. Tighten or raise and tighten existing span or messenger wire.

Tap the span or messenger wire to the designed height after removing tension.

C. To tighten the span or messenger wire, attach another tensioning device between the loose end of the span or messenger wire and the span and tighten. After reaching the designed tension, re-tighten the 3-bolt guy clamps and remove tensioning devices. Adjust the span bonding jumper as required. The engineer will decide if adjustment is needed at both ends of 1 span to tighten or raise and tighten the span or messenger wire.

D. To loosen an 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.

838.3.5 Relocating of Messenger Attachment.

Drill a hole in the existing pole. Take care that 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.

838.3.6 Transfer of Existing Span or Messenger Attachment.

Drill a hole in the new pole. Move the cable and attachment to the new pole and install using the hardware from the original pole. Provide additional hardware if needed to attach the span or messenger to the new pole. Reattach the messenger bonding jumper to the new pole ground wire.

838.3.7 Removing Messenger Wire, Cable, and Hardware.

A. Remove messenger wire, cable, and hardware with an attached cable or of a cable with a built-in messenger wire in place between poles. This item does not apply to removing a cable from a messenger wire that remains in place or removing a messenger wire with no attached cable.

B. Use a tensioning device to remove the tension from the clamps before release. Lower the messenger wire to the ground after removing the clamps and releasing the remaining tension. Detach the cable that is lashed or taped to the messenger wire.

838.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Span wire cable between poles by the linear foot from the center of 1 pole or structure to the center of pole or structure the wire is attached to and accepted. The Department will not measure span wire wrapped around the pole or structure.
2. Dead end, intermediate, or angular messenger wire attachments as the number of attachments made to a pole and accepted. The Department will measure down guy assemblies in accordance with Section 840.
3. Adjusted span or messenger wires as the number of span or messenger wires adjusted and accepted.
4. Relocations as the number of messenger wire attachments relocated and accepted.
5. Span or messenger attachment transfers as the number of span or messenger wire attachments transferred and accepted.

6. Messenger wire removed and returned as the number of linear feet of messenger wire with attached cable removed and returned to the DelDOT Sign Shop.

838.5 Basis of Payment.

A. The Department will pay the quantity of span wire placed and accepted at the contract unit price. Price and payment constitute full compensation for providing and placing span wire and all related hardware. The Department will consider the following as included in the pay item and will make no separate payment for:

1. Wood pole preparation.
2. Labor and materials to attach span wire between poles.
3. Span wire wrapped around the pole or structure.
4. Installation of span insulators.

B. The Department will pay the quantity of dead end, intermediate or angular intermediate messenger wire attachments made to a pole and accepted at the contract unit price. Price and payment will constitute full compensation for providing the messenger wire attachment hardware and attaching the wire to a wood or steel pole. The Department will pay for down guyassemblies in accordance with Section 840.

C. The Department will pay the quantity of span or messenger wires adjusted and accepted at the contract unit price. Price and payment will constitute full compensation for tightening, raising, or loosening the span or messenger wire. The Department will make no separate payment for removing or installing tape on a span to clear a path for tensioning devices.

D. The Department will pay the quantity of relocated messenger attachments completed and accepted at the contract unit price. Price and payment constitute full compensation for all work and materials required to relocate messenger attachments.

E. The Department will pay the quantity of transferred span or messenger attachments completed and accepted at the contract unit price. Price and payment constitute full compensation for all work and materials required to transfer span or messenger attachments.

F. The Department will pay the quantity of messenger wire removed and disposed of and accepted at the contract unit price. Price and payment constitute full compensation for all work and materials required to remove and dispose of messenger wire, cable, and attachments.

ITEM	DESCRIPTION	UNIT
838001	PROVIDE AND INSTALL SPAN WIRES, 7/16”	LF
838002	PROVIDE AND INSTALL SPAN WIRES, 1/4”	LF
838003	PROVIDE AND INSTALL DEAD END MESSENGER WIRE ATTACHMENT	EACH
838004	PROVIDE AND INSTALL INTERMEDIATE MESSENGER WIRE ATTACHMENT	EACH
838005	PROVIDE AND INSTALL ANGULAR INTERMEDIATE MESSENGER WIRE	EACH
838006	ADJUSTMENT OF SPAN OR MESSENGER WIRE	EACH
838007	RELOCATION OF MESSENGER ATTACHMENT	EACH
838008	TRANSFER OF EXISTING SPAN OR MESSENGER ATTACHMENTS	EACH

ITEM	DESCRIPTION	UNIT
838009	REMOVAL OF MESSENGER WIRE, CABLE AND HARDWARE	LF

SECTION 839 — WOOD POLES

839.1 Description.

This work consists of providing, placing, cutting, or removing wood poles.

839.2 Materials.

A.	Borrow Type F	Section 1001
B.	#6 AWG Solid Bare Copper Ground Wire	Section 832; Section 1074
C.	Ground Rod	Section 833
D.	Ground Clamp	Section 833
E.	Topsoil	Section 908
F.	Seed	Section 908
G.	Mulch	Section 908
H.	Wood Pole, Class II – 40-feet long	ANSI O5.1
I.	Copper Butt Plate	NESC 094 Grounding Electrodes
J.	Copper Coated Fasteners	

839.3 Construction.

839.3.1 Installation.

A. Locate the pole in accordance with the contract.

B. Excavate a 10-foot deep hole with a diameter as close as possible to the diameter of the pole.

C. Place a wood pole, with a butt plate and a #6 bare copper ground wire from the butt plate to the top of the pole, plumb in all directions. The Department will allow use of a ground rod in place of the butt plate.

D. Backfill the space around the pole with existing soil unless deemed unusable by inspector, use Borrow, Type F.

E. Grade the soil around the pole high enough to ensure that water drains away from the pole.

F. Place topsoil, seed, and mulch in accordance with Section 908.

G. Use copper-coated fasteners placed no more than 3-feet apart to attach the ground wire to the wood pole. Drive the ground rod in accordance with Section 833.

839.3.2 Cutting Poles.

A. Remove metal from the pole in the area of the planned cut.

B. Secure lifting equipment to the pole above the planned cut.

C. Cut the pole to the height shown in the contract.

D. Lower the cutoff piece of pole to the ground and remove from the job site along with metal removed before cutting.

E. Dispose of materials in accordance with Section 106.8.

839.3.3 Removing Poles.

A. Remove hardware and connections attached to the pole, including the ground rod.

B. Extract the pole from the ground.

C. Backfill the remaining hole with Type F Borrow to 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 in place.

839.4 Method of Measurement.

The Department will measure the quantity of wood poles as the number of wood poles provided and placed or cut, stabilized, and removed.

839.5 Basis of Payment.

A. The Department will pay the quantity of wood poles provided, installed, and accepted at the contract unit price.

1. Price and payment constitute full compensation for:

   a. Providing the wood pole;

   b. excavating the hole;

   c. setting the pole;

   d. providing and placing the butt plates and ground rods;

   e. providing and installing fasteners for the ground wire; and

   f. backfill and backfilling;

B. The Department will pay for ground wire in accordance with Section 832.

C. The Department will pay the quantity of wood poles cut and accepted at the contract unit price. Price and payment constitute full compensation for all work required to cut the wood poles:

D. The Department will pay the quantity of wood poles removed at the contract unit price.

1. Price and payment constitute full compensation for:

   a. Removing and disposing of the pole and attached parts;

   b. backfill and backfilling;

   c. grading;

   d. providing and placing topsoil; and

   e. stabilization.

ITEM	DESCRIPTION	UNIT
839001	PROVIDE AND INSTALL WOOD POLE	EACH
839002	CUTTING OF WOOD POLE	EACH
839003	REMOVAL OF WOOD POLE	EACH

SECTION 840 — DOWN GUYS AND ANCHORS

840.1 Description.

This work consists of providing, placing, relocating, or removing down guys and anchors.

840.2 Materials.

A. Guys and Anchors Section 1077

840.3 Construction.

A. Provide and Place Down Guys and Anchors.

1. Provide all materials to place down guys and anchors.
2. Drive anchors at a 45-degree angle away from the pole into firm and undisturbed ground. Drive the anchor until no more than 6-inches of the rod, including the eye, remains above ground.
3. Attach the down guy or sidewalk guy wire to the pole at the location on the pole determined by the engineer. Install the guy wire in accordance with applicable electrical and safety codes.
4. Install the strain insulator based on field conditions as determined by the engineer. Install the strain insulator no 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 anchored to the guy wire. Bond the guy wire to the wood pole ground.

B. Relocate Down Guys and Anchors.

1. When moving the location of a down guy or a sidewalk guy and the associated anchor, keep the guy attached to the pole while changing the anchor location.
2. Salvage as much of the existing guy as possible.
3. Submit the down guy or the sidewalk guy relocation method to the engineer for approval.

C. Down Guy and Anchor Removal.

Submit the anchor and the down guy or the sidewalk guy removal method to the engineer for approval.

D. Providing and Placing Overhead Guys.

1. Provide and place overhead guys in accordance with applicable electrical and safety codes.
2. 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 no 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.

E. Relocating Overhead Guys.

Submit the overhead guy relocation method to the engineer for approval.

F. Overhead Guy Removal.

Submit the overhead guy removal method to the engineer for approval.

840.4 Method of Measurement.

The Department will measure the quantity of anchors and down guys, sidewalk guys, or overhead guys as the number provided and placed, relocated, removed, and accepted.

840.5 Basis of Payment.

A. The Department will pay for anchors and down guys, sidewalk guys or overhead guys provided, placed, and accepted at the contract unit price. Price and payment constitute full compensation for all work to complete the item. The Department considers bonding of the guys as incidental to the item and will make no separate payment for bonding

B. The Department will pay for relocating anchors and down guys, sidewalk guys or overhead guys at the contract unit price. Price and payment constitute full compensation for all work to complete the item.

C. The Department will pay for removed anchors and down guys or sidewalk guys at the contract unit price. Price and payment constitute full compensation for work to complete the item.

ITEM	DESCRIPTION	UNIT
840001	PROVIDE AND INSTALL DOWN GUY AND ANCHOR	EACH
840002	PROVIDE AND INSTALL OVERHEAD GUY	EACH
840003	RELOCATION OF DOWN GUY AND ANCHOR	EACH
840004	RELOCATION OF OVERHEAD GUY	EACH
840005	REMOVAL OF DOWN GUY AND ANCHOR	EACH
840006	REMOVAL OF OVERHEAD GUY	EACH

SECTION 841 — WEATHERHEADS

841.1 Description.

This work consists of providing and installing weatherheads.

841.2 Materials.

A. Close Nipple Section 1062

B. Lock Nut Section 1062

C. Conduit Bushing – Plastic Conduit Bushing or Insulated Bushing.

841.3 Construction.

A. Use a hole saw to drill a hole 6-inches from the top of the steel pole on the side parallel with the span cable.

B. Install the weatherhead on a close nipple.

C. Place a lock nut on the nipple and then place the assembly through the hole drilled into the steel pole.

D. Use a bushing on the end of the nipple inside the steel pole, when placing the weatherhead assembly.

E. Tighten the lock nut against the outside of the steel pole to hold the complete assembly in place.

841.4 Method of Measurement.

The Department will measure the quantity of weatherheads as the number provided, installed, and accepted.

841.5 Basis of Payment.

The Department will pay for weatherheads at the contract unit price per each. Price and payment constitute full compensation for providing and installing the weatherheads, including all hardware.

ITEM	DESCRIPTION	UNIT
841001	PROVIDE AND INSTALL WEATHERHEAD, UP TO 3”, ON STEEL POLE	EACH

SECTION 842 — SERVICE PEDESTAL AND SAFETY SWITCH

842.1 Description.

This work consists of providing and installing or removing lighting and traffic service pedestals and safety switches.

842.2 Materials.

A.	Conduit Fittings, Galvanized Steel	Section 831; Section 1062
B.	Cables and Wires	Section 832
C.	Ground Rod and Wire	Section 833
D.	PCC, Class B	Section 1022
E.	Hex Bolts and Washers, Stainless Steel	Section 1039
F.	Square Tube Steel Posts, Galvanized	Section 1039
G.	Service Pedestal and Safety Switch	Section 1078
H.	Pedestal Board	Section 1078

842.3 Construction.

A. General.

1. Perform work in compliance with NEC, NFPA, and 2017 National Electric Safety Code (NESC) standards, and with utility company minimum requirements.
2. Install the electric service pedestal as shown in the Standard Construction Details.
3. Locate the line side safety switch and meter adjacent to the service drop location:

   Fuse and size the line side safety switch to service.
4. Do not fuse the load side safety switch:
   a. Mark the safety switch with a weatherproof stamp. Label switches as follows to denote the devices the switches serve:
      i. Lighting.
      ii. Signal.
      iii. Camera.
      iv. Repeater.
      v. VMS.
      vi. Detector.
      vii. RWIS denoting the device it serves.

B. Service Pedestal.

1. In addition to this section, install in accordance with Section 705.
2. When placing a pole base in an existing concrete sidewalk, saw cut the concrete in a square pattern or remove the concrete to the nearest joint.

3. Place Conduit.
   a. Use a conduit adapter to connect sweeps to underground conduit and conduit leading to the safety switch and meter.
   b. Install 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. Ensure that the conduit extends 3-feet above the surrounding grade.
4. Install square tube steel posts in accordance with Standard Construction Details in concrete footings with 25-pounds of concrete at each leg, just below grade and as directed by the engineer.
   a. Provide 3-inch clearance on the base of footing to conduits.
   b. Determine the finished length of the tubular steel posts by adding 5-feet to the combined height of the meter and the safety switch.
5. Backfill around the conduit and concrete footings, and dispose of excess or unsuitable materials:
   a. Backfill 24 hours after concrete placement and in accordance with Section 202.
   b. Remove all excess material.
6. Install ground rods in accordance with the contract and Section 833.
7. Attach the pedestal board to the steel posts using stainless steel hex bolts and washers.
8. Arrange for an inspection by a Delaware-licensed electrical inspection agency. Inspections include all lighting system work including service, branch circuits, junction wells, underground conduit, and all grounding and bonding:

   Provide certification documentation for the Delaware-licensed electrical inspection agency to the engineer for approval before starting work.
9. Remove electric service from wood or metal pole, if required by the contract and as directed by the engineer.
10. Install 24-inch x 15-inch x 8 1/2-inch minimum weatherproof lighting control cabinet, if required by the contract and as directed by the by the engineer.
11. Install 24-inch x 15-inch x 8 1/2-inch minimum weatherproof traffic control cabinet, if required by the contract and as directed by the by the engineer.

842.4 Method of Measurement.

The Department will measure the quantity of electric services as the actual number installed and accepted.

842.5 Basis of Payment.

The Department will pay for the quantity of electric services at the contract unit price for each installed and accepted. Price and payment constitute full compensation for all materials, installation, and inspection by a Delaware licensed electrical agency.

ITEM	DESCRIPTION	UNIT
842001	ELECTRIC SERVICE ON WOOD POLE	EA
842002	ELECTRIC SERVICE ON METAL POLE	EA

ITEM	DESCRIPTION	UNIT
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	PROVIDE AND INSTALL EMBEDDED METERED SERVICE PEDESTAL (100 AMP)	EA
842007	PROVIDE AND INSTALL ELECTRICAL UTILITY SERVICE EQUIPMENT 120/240	EA

SECTION 843 — HIGHWAY LIGHTING ELECTRICAL TESTING

843.1 Description.

This work consists of electrical testing for highway lighting systems.

843.2 Materials.

Not applicable.

843.3 Construction.

A. When this item is required to test a highway lighting system constructed as part of the contract, include a 1-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, or other areas.

B. The highway lighting system is comprised of all contract items for lighting, including 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 or relocated existing lighting facilities.

C. Perform work in accordance with the latest editions of the NEC, the NESC, local utility company requirements, state and local laws, and ordinances governing the work.

D. Perform 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.

E. Apply for, obtain, and pay for all permits, licenses, and inspections required by this bid item and local regulations.

F. Engage a third-party Delaware-approved licensed electrical inspection agency to inspect all electrical installations.

G. Submit the types, styles, or catalog numbers of testing equipment at least 30 calendar days before beginning each test. Include a written certification stating when the testing equipment was last calibrated. Ensure the calibration date is within 180 calendar days of the date of testing. Perform all tests in the presence of the engineer.

843.3.1 Ground Resistance Testing.

A. Measure ground resistance with a 3-terminal, fall-of-potential, direct-reading, battery-powered earth tester with a 0.50 to 500-ohm scale or digital read-out. Ensure the resistance is 25-ohms or less.

B. Perform the test in accordance with 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.

C. Install grounding rods and foundation grounds a minimum of 10 calendar days before testing, unless otherwise determined by the engineer. Drive 2 auxiliary copper clad ground rods into the ground a minimum of 3-feet apart.

D. Provide the lateral spacing for each test rod in writing on a test report form. The engineer will approve the spacing. Isolate each ground rod or foundation ground with the bond wires disconnected when performing the test. Ensure the resistance to ground is 25-ohms or less. Perform 2 ground resistance tests unless noted otherwise in the contract.

843.3.2 System Testing.

A. Use a third-party master electrician licensed in the State of Delaware to perform system testing for lighting installations.

B. Test insulation from ground, roadway lighting, performance burn-in, and illuminance circuits as follows:

1. Insulation From Ground.

   Test underground circuits for resistance to ground with a megger before and after burying the conduit and wiring and after placement and connection of ground rods. Inspect, repair, and retest circuits with measurement readings less than 10-megaohms to ground

2. Roadway Lighting Circuits.

   a. Determine the insulation resistance on all cables of every circuit, except those installed in lighting structures. The Department will not accept cable insulation with resistance measurement readings less than 10-megaohms at 500 volts DC.

   b. 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.

   c. The Department will not consider removing water from the conduit of a faulty circuit as a repair. If a circuit fails the insulation resistance test and water removal allows the circuit to pass, replace the conductors and re-test the new circuit. Allow at least 1-minute between circuit testing and any re-test.

C. Demonstrate to the engineer that all conductors are continuous, free from short circuits and unspecified grounds, and that all circuits are properly connected.

D. Take voltage readings, with load and without load, at the power supply side of the control cabinet main breaker. The tolerance for readings with load is +/- 5 percent of nominal voltage. Take voltage readings at the last light of each circuit. The Department will accept a voltage reading if it is within 5 percent of the reading with load at the supply point.

E. Take current ampere readings with a full lighting load on the load side of each distribution breaker in the control cabinet. The Department will accept a current reading if it does not exceed 80 percent of the breaker rating.

F. Performance Burn-In.

1. After addressing all testing issues 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 energized from the same utility company service point. The Department will not accept burn-in test of individual circuits or groups of lights.

2. At the end of the burn-in test, inspect all lights and equipment for normal operation. Correct failures occurring during the test period. Make necessary repairs or replacements and then retest the repaired portion of the system.

G. Illuminance.

1. After energizing the lights 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.
2. Adjust all luminaires not meeting the manufacturer's or DelDOT's standards.
3. Conduct an illumination test to determine illumination characteristics of the roadway lighting system. Submit test procedures to the engineer for approval 2-weeks before conducting the test. Submit 4 copies of the test results to the engineer.

843.3.3 Inspection.

A. The engineer will inspect and approve all work before covering it up.

B. Use a third-party inspection agency for certification and sticker placement for the entire electrical system. Ensure that this inspection agency is independent and licensed to operate in the State of Delaware, having no affiliation with the Department or the contractor.

C. The Department will conduct inspections during and after completing the work.

D. The certification inspection includes the lighting control cabinets, cables, and all other components of the lighting system.

E. Submit 4 copies of the inspection agency's certification document to the engineer. The Department will not allow energizing of the lighting system until 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 Department will also require the inspection agency to submit a cut-in card to the utility company before energizing the service.

F. 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 843.3. If the highway lighting system is defective because of abnormal operation or deterioration, as listed in Section 843.3, the Department will require repair or replacement of the defective equipment.

843.3.4 As-Built Plans.

A. Upon completion of the work, submit 2 sets of as-built plans, including 1 set of CADD files, showing the location of all buried electrical circuits, with lighting system elements dimensioned from fixed objects or from survey stations.

B. Provide vertical dimensions related to the finished grade for all underground electrical facilities. Include in the as-built plans the project plan and detail sheets, with changes shown.

C. Submit paper and electronic copies of catalog cuts of all equipment used for the lighting system. Keep a daily record of where the items are placed to ensure the accuracy of the as-built plans.

843.3.5 Highway Lighting System Warranty.

A. Secure the manufacturer's warranties or guarantees on electrical and mechanical equipment. Submit the warranties or guarantees to the engineer upon final acceptance of the completed highway lighting system. In addition to the manufacturer's warranties or guarantees, provide a warranty for the complete, installed highway lighting system for 1 calendar year beginning at the initial acceptance of the highway lighting system.

B. The Department will consider the highway lighting system defective if the Department discovers any of the following conditions by visual inspection or by inspection with testing equipment within the warranty period:

1. Non-operational lamps or ballasts;
2. failure to operate, in whole or in part;
3. power wire grounding less than 10 megaohms;
4. shifts in pole or foundation alignment;
5. short circuits or open circuits anywhere within the system;
6. deterioration of finishes, plating, or paint not normal and customary in the environment of equipment installation;
7. settlement of trench backfill;
8. defective fuses; and
9. defective or improperly installed splices.

C. Repair defects identified by the Department during initial or periodic inspections in accordance with this specification, including all highway lighting systems and components within the project limits. Begin highway lighting system repairs immediately following notice of the lighting system defect unless weather limitations prevent the corrective work. Provide notification to the Department before beginning corrective work.

D. The Department will not consider the highway lighting system as substantially complete until correction of the deficiencies noted during the primary inspection. Provide a maintenance bond for item 843001 – Electrical Testing upon substantial completion. Provide a maintenance bond meeting the following requirements:

1. A bond sum equal to 100 percent of the value of all highway lighting system items the Department paid to the contractor;
2. With original signatures, in ink, and not mechanical reproductions or facsimiles of any kind, naming the contractor as the principle;
3. term of 1-year beyond the completion of the highway lighting system work; and
4. written by a surety or insurance company licensed to write surety bonds in the State of Delaware by the Delaware Department of Insurance.

843.4 Method of Measurement.

Not applicable.

843.5 Basis of Payment.

A. The Department will pay for electrical testing at the contract lump sum price. Price and payment will constitute full compensation for:

1. Providing all testing equipment, including ground rods;
2. performing the tests;
3. inspections by a licensed third-party inspection agency;
4. preparing the reports;
5. performing necessary retesting;
6. providing the warranties; and

7. performing necessary corrective work.

ITEM	DESCRIPTION	UNIT
843001	ELECTRICAL TESTING	LS

SECTION 844 — EMERGENCY PREEMPTION DETECTOR

844.1 Description.

This work consists of providing, assembling, wiring, and installing emergency preemption detectors on a mast arm or span wire.

844.2 Materials.

A. Detector Cable. 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 from the Following Manufacturers:

1. 3M Company Cat. No. 33.
2. Plymouth Rubber Cat. No. 3117.
3. Permacel Cat. No. P29.
4. Approved equal.
5. Colors needed:
   a. Violet
   b. Red
   c. Green
   d. Yellow
   e. Blue

844.3 Construction.

A. Assemble mounting hardware in accordance with the contract. Use thread sealing tape on the mounting hardware.

B. Drill a 1/8-inch diameter weep hole on the bottom of the detector. Install the emergency preemption detector in accordance with the contract. Attach the 4-conductor detector cable to the 4 terminal screws within the emergency preemption detector unit, in accordance with the manufacturer's specifications.

C. Identify the detector cable home run within the control cabinet by a violet band and a band of a different color to denote the direction of the detector as follows:

1. RED – northbound eye
2. GREEN – eastbound eye
3. YELLOW – southbound eye
4. BLUE – westbound eye

D. Dispose of removed emergency preemption detectors in accordance with the contract.

844.4 Method of Measurement.

The Department will measure the quantity of emergency preemption detector installations as the number provided, assembled, and installed on span wire or traffic signal mast arms, and accepted.

844.5 Basis of Payment.

The Department will pay for emergency preemption detectors at the contract unit price per each. Price and payment constitute full compensation for providing, assembling, and installing the emergency preemption detectors and removing and delivering replaced units and hardware to the Department.

ITEM	DECRIPTION	UNIT
844001	PROVIDE AND INSTALL OPTICOM EMERGENCY PREEMPTION DETECTOR	EACH

SECTION 846 — LOOP DETECTOR

846.1 Description.

This work consists of providing and placing loop detectors.

846.2 Materials.

B.	Backer Rod, Closed Cell	Section 1043
C.	Conduit, Galvanized	Section 1062
D.	Loop Detector	Section 1079
E.	Tape	Section 1074.2.F
F.	Heat Shrink Tubing	Section 1074.2.G.1
G.	Loop Wire	Section 1079.1
H.	Home Run Cable	Section 1074.1.D
I.	Backer Rod – 5/8-inch closed cell foam.	Section 1043
J.	Junction Well Splices	Section 1074.2.G
K.	Splicing Kit	Section 1074.2.G.3
L.	PCC Patching	Section 1023
M.	Asphalt Production	Section 1014
N.	Joint Sealant	Section 1042.1.B

846.3 Construction.

846.3.1 Loop Wire Installation.

A. Sawcut a groove in the pavement 5/8-inch wide and at least 3 1/2-inches deep in accordance with Section 762. Remove sharp edges in the saw cut and round the corners. Blow out the saw cut with compressed air to remove loose material before sealing.

B. Install the loop detector wire using blunt tools to prevent damage to the polyethylene outer cover.

C. Tag 1 end of a loop detector wire to indicate start with an “S.”

D. Place a 5/8-inch backer rod on top of the wire in the saw cut as needed to secure the wire within the saw cut.

E. The engineer may require a high voltage ground test with a 500 volts DC megger after completion of the loop detector installation and before sealing saw cuts. If the resistance to ground is less than 100 megaohms, remedy the work.

F. Apply a sealer, and sealer accelerant or retarder, if necessary, in the saw cut, in accordance with the manufacturer’s directions. Protect the saw cut area from traffic until the sealer has set. Place 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.

G. Install 2 loop detector wires in a saw cut from the loop to the edge of the road. Extend these 2 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.

H. 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, in accordance with the contract. Install loop detector lead-in wire through the rotary drill hole into the junction well and splice accordingly.

I. When the junction well is not directly behind the edge-of-pavement, curb or sidewalk, 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. Install the loop detector lead-in wire through the rotary drill hole, 1 1/2-inch conduit, and junction well and splice accordingly.

J. Install the loop detector wire in a continuous manner and without splices from the junction well through the saw cuts and through the conduit.

846.3.2 Home-run WireInstallation.

A. Refer to Sections 831 and 832 for cable installation and conduit installation specifications. Refer to the contract for details.

846.3.3 Splicing.

A. Complete splices between the loop detector wire and home-run cable in accordance with the contract. Solder conductors 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 solderingiron, and solder with a rosin core solder. Insulate each soldered connection with heat-shrink tubing.

B. Test all circuits after completing the electrical and mechanical connections and before installing the splicing kit. Install an approved splice kit in accordance with the manufacturer's instructions. The Department will perform a continuity test at the cabinet after application of the splicing kit.

C. Remake the splice if the splice becomes faulty within 90 calendar days after splicing. The Department's ITS technician will make the determination if the splice is watertight or not or if wires are crossed or mislabeled.

D. Provide an overlap of the conductor insulation of at least 1 1/2-inches at each end of the heat-shrink tube or the open end of the end cap of heat-shrink tubing after contraction.

846.4 Method of Measurement.

The Department will measure the quantity of loop detector wire or conduit as the number of linear feet of saw cut where loop detector wire is placed, sealed, and accepted. The Department will include the length of loop wire installed between the saw cut and the junction well in this measurement.

846.5 Basis of Payment.

A. The Department will pay the quantity of loop detector wire provided, placed, sealed, and accepted at the contract unit price. Price and payment constitutes full compensation for:
   1. Sawcutting and
   2. providing and placing:
      a. loop detector wire,
      b. backer rod,
      c. sealer, and

d. sealer accelerant or retarder.

3. junction well splicing.

B. The Department will pay the quantity of 1 1/2-inch galvanized rigid metal conduit detector sleeve with loop wire provided, placed, and accepted at the contract unit price. Price and payment constitutes full compensation for:

1. Providing and placing galvanized rigid metal conduit;
2. loop wire;
3. drilling required for installation;
4. concrete or pavement patching;
5. sealing the conduit ends; and
6. internal bushings.

ITEM	DESCRIPTION	UNIT
846001	PROVIDE AND INSTALL LOOP WIRE 1-CONDUCTOR #14 AWG ENCASED IN 1/4" FLEXIBLE TUBING IN A LOOP SAWCUT	LF
846002	PROVIDE AND INSTALL A 1 1/2-INCH GALVANIZED RIGID METAL CONDUIT DETECTOR SLEEVE WITH LOOP WIRE	LF

SECTION 847 — LIGHTING CONTROL CABINETS

847.1 Description.

This work consists of providing and installing lighting control cabinets.

847.2 Materials.

A. Lighting Control Cabinets Section 1080

847.3 Construction.

A. Type M, Type P, and Type R Cabinets.

1. Provide and install all equipment necessary to provide a functioning lighting control cabinet. This may include mounting to an existing pole or existing cabinet base.
2. Mount cabinets on concrete base.
3. Place a bead of sealant under the cabinet on 3 sides.
4. Do not seal the side with the lowest elevation to provide drainage from within the cabinet.
5. Coat bolts with anti-seize compound.
6. Bolt cabinet to base.
7. Place a bead of sealant on the outside of the cabinet on the same 3 sides as in Section 847.3.A.3, above.
8. Install photoelectrical control on the side or back of the lighting control cabinet, using a line box (LB) conduit fitting. After installing the photoelectrical control and LB conduit fitting, seal the area around the hole in the cabinet. Photoelectrical control can also be installed inside of the cabinet behind a plexi-glass shield, if required by the contract and as directed by the engineer.

847.4 Method of Measurement.

The Department will measure the quantity of lighting control cabinets as the number provided, installed, and accepted.

847.5 Basis of Payment

The Department will pay for lighting control cabinets at the contract unit price per each. Price and payment constitute full compensation for providing and installing all materials.

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
847006	LIGHTING CONTROL CABINET – 100 A	EACH
847007	LIGHTING CONTROL CABINET – 200 A, 240/480V	EACH

847008	LIGHTING CONTROL CABINET – 60 A, WITH SERVICE DISCONNECT	EACH

SECTION 850 — LUMINAIRE

850.1 Description.

This work consists of providing and installing LED light fixtures (luminaires) on poles (not inclusive in this item) with wattage, lamp type, and distribution type or removing luminaires.

850.2 Materials.

Provide a complete fixture with a heavy duty, cast aluminum housing, door with extruded aluminum heat sink, toolless entry, hinged removable power tray door for easy maintenance, and fastening hardware that is stainless steel or zinc plated steel. The fixture shall meet ANSI 136.31 3.0 G vibration requirements. Fixture shall have a two bolt slip fitter system for mounting on a 1 1/4-inch to 2 3/8-inch mounting arm connection. A grey powder coat finish shall be applied to the fixture unless otherwise shown on the plans, or as directed by the engineer. Provide electrical materials in accordance with the NEC of the NFPA, and all local and state laws and ordinances governing such installations.

A. Cobra-Head Luminaire

1. Wattage, lamp type, and distribution type in accordance with the contract.
2. Optical assembly includes an aluminum reflector with a heat and impact-resistant tempered sag glass lens or acrylic or polycarbonate resin clear globe.
3. Refractor door sealed with a gasket.
4. Refractor door latch, constructed of non-corrodible material, sized to enable easy handling that produces an audible click when locked.
   a. Ventilating channel, with charcoal filter.
   b. Luminaire leveling pad capable of adjusting +/- 3 degrees for leveling.

B. Underpass Luminaire

1. Luminaire listed as suitable for wet locations in accordance with UL standard No. 1598, featuring sealed and filtered optical assemblies. LED module with robust, heat-dissipating housing and durable electrical connections.
2. Cast aluminum housing, painted with premium quality gray or dark bronze paint.
3. Stainless steel bolted or latched door closure disengages top electrical cover for easy access to LED drivers, surge protection, luminaire disconnect, and terminal block.
4. Formed aluminum reflector and socket assembly with a chemically bonded lightweight non-breakable glass finish, removable only by using a screwdriver.
5. Factory installed mounting holes in the back and conduit entrances in the sides and top.

C. High Mast Luminaire

1. Wattage, lamp type, and distribution type in accordance with the contract.
2. Fixture with a natural aluminum finish or painted light gray.
3. Luminaire with formed, cast, or drawn from low copper aluminum housing free of cracks and excessive porosity, with all seams welded.

4. Reflector housing constructed separately from the fixture reflector.
5. Slip fitter that securely attaches the fixture to the tenon and ring assembly with a minimum of 2 bolts and a clamp.
6. Lens of tempered or prismatic glass, with sag.
7. Water and dust tight optical compartment.

D. Fixture Criteria

The fixture shall also meet the following criteria:

1. Lamps: Light Emitting Diode (LED)
2. Wattage:
   a. 50 Watt Maximum for Item No. 850005
   b. 90 Watt Maximum for Item No. 850001 and 850006
   c. 175 Watt Maximum for Item No. 850002 and 850007
   d. 250 Watt Maximum for Item No. 850003 and 850008
   e. 450 Watt Maximum for Item No. 850004
3. Voltage: 120V 277V
4. CRI: 70 Minimum
5. Lumens:
   a. 3,000 to 5,000 for Item No. 850005
   b. 8,000 to 12,000 for Item No. 850001 and 850006
   c. 16,000 to 20,000 for Item No. 850002 and 850007
   d. 27,000 to 31,000 for Item No. 850003 and 850008
   e. 40,000 to 50,000 for Item No. 850004
6. Rated L70 Lamp Life: 60,000-hours minimum when operated at 77-degrees F.
7. Distribution: Type II, Type III, or Type IV (unless otherwise indicated).
8. Color Temperature: 3,000 K 4,000 K. High mast luminaires may have a color temperature up to 5,000K.
9. Driver: 0 10V dimming.
10. IP66 Rating for optical portion of the housing.
11. 10kV/10kA minimum internal surge suppression module, meeting UL 1449/ANSI C62.41.2 Category C.
12. NEMA 7-pin Photocontrol Receptacle with a non-clear Shorting Cap.

E. Point Value:

Luminaire mounting height shall be as indicated on drawings. Luminaire shall provide point illumination of not less than the given values in the table that follows:

Table 850.2-1. Foot-Candle Point Table by HPS Luminaire Equivalent Wattage

Luminaire	Point 1 (fc)	Point 2 (fc)
Luminaire (LED), 75 Watts HPS Equivalent	0.10	0.11
Luminaire (LED), 150 Watts HPS Equivalent	0.16	0.22
Luminaire (LED), 250 Watts HPS Equivalent	0.27	0.37
Luminaire (LED), 400 Watts HPS Equivalent	0.46	0.55
Luminaire (LED), 640 Watts HPS Equivalent	0.55	0.60

Point 1 coordinates are 90 feet longitudinal distance. Point 2 coordinates are 90 feet longitudinal and 30 feet transverse distance. The point values given in the table are based on a 30-foot mounting height with a Light Loss Factor of 1. The point values produced by the submitted fixture shall be included with the fixture submittal.

Metal parts shall be free of burrs and sharp corners and edges. Doors, frames, and other internal access points shall be smooth operating and free of light leakage under operating conditions.

Factory applied labels shall comply with UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place. Labels shall include the following lamp characteristics:

1. CCT and CRI for all luminaires.
    a. Luminaire finish shall be manufacturers standard paint applied to factory assembled and tested luminaire before shipping.

E. Warranty

1. Provide a warranty for the luminaire to be free from defects and guaranteeing the performance of the luminaire to operate as indicated for a period of 5-years from the date of delivery. Transfer all manufacturer warranties to the Department.

850.3 Construction.

A. Install luminaires in accordance with the manufacturer's installation instructions and follow the following installation requirements:

1. Comply with NECA 1.
2. Fasten luminaire to pole.
3. Install luminaires at height indicated on drawings and level and square with finished grade.
4. Install a grounding conductor within the lighting pole. Connect one end of the grounding conductor to the grounding screw on the luminaire and the other end to the ground rod conductor in the transformer base of the pole.
5. Perform an illumination test after positioning and leveling.

B. Luminaire identification decals shall be installed to the luminaire housing in accordance with NEMA conventions. Ensure the decal is readily visible from the ground and meets ANSI C136.15 2015 Roadway and Area Lighting Equipment Luminaire Field Identification standard. The decal

shall be solid white and imprinted with the LED wattage. The high-pressure sodium wattage equivalence may be added to the decal as well.

C. Submit catalog cuts, details, shop drawings, manufacturer's specifications, and the IESNA LM 79 and LM 80 test reports to the engineer for approval.

D. Submit the photometric file for the selected luminaire in standard IES electronic format. Clearly indicate the name of the file on the shop drawing.

E. Mark the month and year of lamp installation on the lamp base dating system, with a sharp instrument.

F. After installation of luminaires and control devices and after electrical circuitry has been energized, test units to confirm proper operation.

G. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

H. Luminaires will be considered defective if they do not pass tests and inspections.

I. Provide documentation that demonstrates that the proposed model of LED luminaire has been tested for electromagnetic compliance following the measurement protocols specified in ANSI standard C63.4 2003 and required by 47 CFR 15.31.

J. If the Contract requires each light fixture to be provided with an independent photoelectric control device, provide a photocell with each lighting fixture in place of the shorting cap. Provide photoelectric control using solid state circuitry, cadmium sulfide type with hermetically sealed silicone rectifier rated 120-volt, 60-cycle AC and 1000-watts maximum load. Provide photoelectric control with "Fail On" functionality such that in the event of a photocell becoming inoperative, the light fixture will remain in a permanent "On" state through day and nighttime hours. The photoelectric control shall be twist lock type, with suitable mounting bracket with locking type receptacle.

K. The photoelectric control shall be set to operate, by default factory setting or by field adjustment, using the following criteria:

1. Turn on the light fixture at a minimum vertical illumination value of 3-foot candles.
2. Turn off the light fixture at a maximum vertical illumination value of 6-foot candles.

L. 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.

M. Removing an Existing Luminaire.

1. Remove the luminaire from the pole or davit arm after disconnecting the wires.
2. Tape and secure the wires so that the wires remain available for future luminaire installation.
3. Store removed luminaire on the project site if the contract calls for re-installing the luminaire in a new location.

850.4 Method of Measurement.

A. The Department will measure the quantity of LED luminaires as the number of luminaires provided, installed, and accepted.

B. The Department will measure the quantity of luminaires removed as the number of luminaires removed and accepted.

850.5 Basis of Payment.

A. Price and payment will constitute full compensation for all work necessary to provide and install luminaires.

B. Price and payment will constitute full compensation for all work required to remove existing luminaires and to store luminaires for future re-installation.

C. The Department will pay for accepted quantities at the contract unit price.

ITEM	DESCRIPTION	UNIT
850001	LUMINAIRE (LED), 150 WATTS HPS EQUIVALENT	EACH
850002	LUMINAIRE (LED), 250 WATTS HPS EQUIVALENT	EACH
850003	LUMINAIRE (LED), 400 WATTS HPS EQUIVALENT	EACH
850004	LUMINAIRE (LED), 640 WATTS HPS EQUIVALENT, HIGH MAST	EACH
850005	LED WALL PACK, 75 WATTS HPS EQUIVALENT	EACH
850006	LED WALL PACK, 150 WATTS HPS EQUIVALENT	EACH
850007	LED WALL PACK, 250 WATTS HPS EQUIVALENT	EACH
850008	LED WALL PACK, 400 WATTS HPS EQUIVALENT	EACH
850011	REMOVAL OF LUMINAIRE	EACH

LED Wattages listed above are based on the equivalent output to HPS lighting. Refer to maximum LED Wattages in Section 850.2.

SECTION 851 — ALUMINUM LIGHTING STANDARD

851.1 Description.

This work consists of providing and installing or relocating aluminum lighting standards with single or double davit arms and breakaway transformer bases.

851.2 Materials.

A. Submersible Breakaway Connector Kits — Section 832 or 1074

B. H-taps, C-taps, Butt Splices — Section 832 or 1074

C. Anchor Bolts, Galvanized — Section 1039

D. Fasteners — Section 1044

E. Aluminum Castings, Alloy 356-T6 — Section 1044

F. Anchor Base Plate, Aluminum Alloy 6000 Series — Section 1044

G. Lighting Pole and Davit Arm, Aluminum Alloy 6063-T6

1. Submit Catalog Cuts, Drawings, and Manufacturer's Specifications.

H. Conduit — Section 1062

I. Pole ID Tag, Clear Anodized 1/16-inch thick Aluminum

J. Transformer Base, 356-T6 Cast Aluminum Alloy:

1. Breakaway in Accordance with NCHRP report 350 or MASH testing criteria.
2. Submit FHWA acceptance letters documenting satisfaction of NCHRP Report 350 or MASH crash testing requirements.

K. Lighting Standard

1. Meeting or exceeding the requirements of the latest edition of the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals."
2. Tapered aluminum shaft, with a base welded to the lower end.
3. Pole shaft, pole extensions, and davit arms spun from 1 piece of seamless tubing.
4. With internal vibration dampening device positioned approximately 2/3 of the height of the pole.
5. Extrude strut and arm plates.

L. Electrical materials in accordance with the NEC of the NFPA, and all local and special laws and ordinances governing such installations.

851.3 Construction.

A. Lighting Standard.

1. Submit computations signed and sealed by a professional engineer licensed in the State of Delaware in accordance with AASHTO specifications with year of the edition specified.

2. Install permanent pole ID tag, with smooth edges and rounded corners, to fit the light pole shaft.
3. Secure ID tag to shaft using 4 1/8-inch diameter, 18-8 stainless steel round head drive screws or self- tapping screws.
4. Provide embossed tag displaying information in accordance with the contract.
5. Install lighting structure with bracket arms set perpendicular to the edge of the roadway, unless otherwise noted in the contract.

B. Davit Arm.

1. Drill the light pole with 2 lockbolts to secure the davit arm bracket to the light pole shaft.
2. Slip the davit arm over the top of the light pole shaft.
3. Fit the luminaire end of the davit arm with a 2-inch NPS aluminum pipe tenon.

C. Transformer Base.

1. Splice the lighting cables in the transformer base to #10 AWG wires connected to the luminaire using submersible breakaway connector kits.
2. Splice the pass-through circuits using H-taps, C-taps, or butt splices.
3. Install the access door opening on the side of the pole facing away from traffic.
4. Install anchor bolts in accordance with Section 834.

D. Relocating Lighting Standard and Davit Arm.

1. Remove the luminaire from the lighting standard in accordance with Section 850 and store.
2. Remove the existing lighting standard, transformer base, and davit arm as 1 unit from the existing pole base. Relocate and re-install to the designated pole base in accordance with this section.
3. Re-install luminaires in accordance with Section 850.

851.4 Method of Measurement.

A. The Department will measure the quantity of aluminum lighting standards with davit arms and transformer bases as the number provided, assembled, installed, and accepted.

B. The Department will measure the quantity of lighting standards with davit arm and transformer base relocated as the number relocated and accepted.

851.5 Basis of Payment

A. The Department will pay for the quantity of lighting standards at the contract unit price per each. Price and payment will constitute full compensation for providing, assembling, and installing aluminum lighting standards with a single or a double davit arm and transformer base.

B. The Department will pay the quantity of relocated lighting standards at the contract unit price per each. Price and payment will constitute full compensation for removing and reinstalling existing luminaires and relocating existing lighting standards, davit arms, and transformer bases.

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

SECTION 860 – LATEX PAVEMENT MARKINGS

860.1 Description.

This work consists of providing and installing latex pavement markings.

860.2 Materials.

A.	Latex paint	Section 1071.1.1
B.	Glass beads	Section 1071.1.2

860.3 Construction.

860.3.1 Submittals.

A. Submit a schedule of operations for the engineer's approval before starting any pavement marking work. Submit the schedule 2-weeks before the striping application.

860.3.2 Equipment.

A. Provide the engineer access to the application equipment for inspection. Do not commence work until equipment is approved by the engineer.

B. Keep certificate of analysis for pavement marking paint being applied by the equipment within the vehicle cabin. Provide the certificate of analysis to the engineer upon request.

C. Provide vehicle mounted longitudinal line application equipment with the following characteristics:

1. Capable of applying approved pavement marking material in a manner that will meet the requirements of the contract.
2. Capable of simultaneously applying centerline and edgeline markings at the width indicated in solid or broken patterns or various combinations thereof.
3. Equipped with automatic electrically controlled skip line mechanism capable of retracing the existing markings or applying new markings.
4. Capable of automatically dispensing glass beads onto the painted surface, at the required application rate, by the pressurized gun method.
5. Equipped with at least one steerable gun carriage on the driver's side and at least one on the passenger side.
6. Equipped with a footage counter on each required paint gun, which automatically and continuously measures the length of each line placed, to the nearest foot. Provide proof of calibration to the engineer upon request.
7. Equipped with usage counter, which quantifies the volume of material placed. Provide proof of calibration to the engineer upon request.
8. Equipped with a hand gun to apply special markings.

9. Equipped with heating mechanism capable of heating material to the required application temperature.
10. Equipped with temperature gauges that have been calibrated within the past six months. Provide proof of calibration to the engineer upon request.
11. Equipped with a transfer pump system on machine capable of transferring the paint from the shipping containers at a rate of 25 gallons per minute.
12. Capable of holding 300-gallons of each color paint and 1800-lbs of glass beads.
13. Equipped with a citizens band transceiver for communication or other approved communication device.
14. Mobile and maneuverable enough to produce straight lines and standard curves in true arcs.
15. Equipped with DE MUTCD compliant signage.

D. Clean all parts of the equipment of foreign or different colored material prior to introducing a new material batch.

860.3.3 Pavement marking layout.

A. Perform pavement marking layout as needed to ensure accurate placement.

B. Offset longitudinal lines at least 2-inches from longitudinal pavement joints or seams.

C. Offset longitudinal lines at least 2-inches to the inside of shoulder breaks of pavement.

860.3.4 Application.

A. Clean pavement surface of oil, surface treatment, curing compound, dirt, grease, concrete laitance, and other contaminants to a width at least 4-inches wider than the marking to be applied.

B. Ensure ambient and surface temperatures are at least 50 degrees F and rising, and in accordance with the manufacturer's recommendations. If the manufacturer recommended temperature requirement for the pavement marking material application deviates from these specifications, the manufacturer's recommendations shall hold priority. Confirm the atmospheric and pavement surface conditions with the engineer prior to starting work.

C. Place a quality control strip as directed by the engineer at the beginning of each day’s operations to demonstrate that the application equipment is working properly and applying markings as required. Repeat the demonstration whenever there is a change in equipment settings or as directed by the engineer when the quality of the line being applied is in question. Authorization to proceed will be given by the engineer when the quality control test indicates conformance. If the application of the control strip is on the actual roadway, correct any application that is not in compliance with the contract.

D. Apply pavement marking material in accordance with the contract and the manufacturer’s recommendations. Apply in accordance with the following provisions unless approved otherwise by the engineer.

1. Apply pavement markings in the general direction of traffic.
2. Apply at an application speed of no more than 10 miles per hour.

3. Dispense latex paint at a wet film thickness of 15-mils and apply glass beads at a rate of 7 pounds per gallon of paint applied.
4. All necessary markings shall be installed before the end of the workday. Install the markings as soon as possible after weather interrupts the work.

E. Protect the pavement markings for an adequate time to allow the markings to dry and become track-free using a method approved by the engineer. Follow the manufacturer's recommendations for track-free time.

F. Remove existing pavement markings that conflict with new or altered traffic patterns as well as any layout markings installed that detract from the overall appearance or function of pavement markings in accordance with Section 868.

G. Request engineer to perform retroreflectivity testing once pavement marking at the location is complete.

860.3.5 Evaluation and Correction.

A. The engineer will evaluate the pavement markings for defects after an observation period of 60-days from the date the pavement is opened to traffic. Time charges will not be assessed during the observation period provided all other work is complete. The engineer may waive a portion or all of the 60-day observation period.

B. The engineer will inform the contractor of pavement markings that have failed and that require corrective action.

C. Correct pavement marking defects as directed by the engineer within 30 days of receiving written notification. Examples of pavement marking defects for latex pavement marking material include:

1. Insufficient retroreflectivty, glass bead coverage or bead retention.
2. Damage caused by a vehicle tracking over uncured pavement marking material.
3. More than 5 percent exposure of substrate in any 2000-foot section of longitudinal marking.
4. Discolored marking when compared visually with color chips.
5. Longitudinal marking is more than 2-inches out of place.
6. Insufficient pavement marking thickness.
7. Pavement marking variations more than 3/8-inch from alignment within any 40-foot section of traveled way.
8. Less than 90 percent of material remaining for each individual symbol, transverse pavement marking, or legends.

860.4 Method of Measurement.

A. The Department will measure linear pavement markings as the number of linear feet of pavement markings placed and accepted.

B. The Department will measure symbols and transverse pavement markings as the number of square feet placed and accepted. Symbols and transverse pavement markings will be measured in accordance with the following square foot values:

1. Straight arrow symbol 12.50 ft^2

2. Left and right arrow symbol 15.50 ft²
3. Combination arrow symbol 20.00 ft²
4. "ONLY" legend 23.00 ft²
5. "SCHOOL" legend 35.00 ft²
6. "STOP" legend 23.50 ft²
7. “AHEAD” legend 40.00 ft²
8. Transverse line, 8-inch 0.66 ft² / linear foot
9. Transverse line, 12-inch 1.00 ft² / linear foot
10. Transverse line, 16-inch 1.33 ft² / linear foot
11. Transverse line, 24-inch 2.00 ft² / linear foot
12. "RXR" railroad crossing symbol 69.00 ft²
13. Left and right 18-foot lane reduction arrow symbol 40.90 ft²

C. The Department will measure bike, shared lane, pedestrian, and accessible parking space marking as the number of square feet placed and accepted. Symbol and legend dimensions per the DE MUTCD as described:

1. Bike symbol helmeted bicyclist symbol with a 2' x 6' arrow symbol.
2. Pedestrian symbol walking pedestrian 4' x 8' with a 2’ x 6’ arrow symbol.
3. Accessible parking space marking 40" x 40".
4. Shared lane marking helmeted bicyclist symbol with 5" W chevrons.

860.5 Basis of Payment.

A. The Department will pay the quantity of linear pavement markings at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

B. The Department will pay the quantity of symbols and transverse pavement markings at the contract unit price per square foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and

5. repairing defective work as directed by the Department.

C. The Department will pay the quantity of bike, pedestrian, and accessible parking space symbols at the contract unit price per each. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

ITEM	DESCRIPTION	UNIT
860001	PERMANENT PAVEMENT STRIPING, LATEX, 6"	LF
860002	PERMANENT PAVEMENT STRIPING, LATEX, 12"	LF
860003	PERMANENT PAVEMENT STRIPING, LATEX, SYMBOL/LEGEND	SF
860004	TEMPORARY MARKINGS, LATEX, 4"	LF
860005	TEMPORARY MARKINGS, LATEX, 10"	LF
860006	TEMPORARY MARKINGS, LATEX, 12"	LF
860007	TEMPORARY MARKINGS, LATEX, SYMBOL/LEGEND	SF
860008	TEMPORARY MARKINGS, LATEX, ACCESSIBLE PARKING SPACE MARKING	EACH
860009	TEMPORARY MARKINGS, LATEX, PEDESTRIAN SYMBOL	EACH
860010	TEMPORARY MARKINGS, LATEX, BIKE SYMBOL	EACH
860011	TEMPORARY MARKINGS, LATEX, SHARED LANE SYMBOL	EACH

SECTION 861 – EPOXY PAVEMENT MARKINGS

861.1 Description.

This work consists of providing and installing epoxy pavement markings.

861.2 Materials.

A.	Epoxy paint	Section 1071.2.1
B.	Type 1 glass beads	Section 1071.2.2
C.	Type 4 glass beads	Section 1071.2.3
D.	Black contrast markings	Section 1071.2.4
E.	Black aggregate	Section 1071.2.5

861.3 Construction.

861.3.1 Submittals.

A. Submit a schedule of operations for the engineer's approval before starting any pavement marking work. Submit the schedule 2-weeks before the striping application.

861.3.2 Equipment.

A. Provide the engineer access to the application equipment for inspection. Do not commence work until equipment is approved by the engineer.

B. Keep certificate of analysis for pavement marking paint being applied by the equipment within the vehicle cabin. Provide the certificate of analysis to the engineer upon request.

C. Provide vehicle mounted longitudinal line application equipment with the following characteristics:

1. Capable of applying approved two-component epoxy pavement marking material in a manner that conforms to the manufacturer's requirements and the requirements of the contract.
2. Equipped with material reservoirs, or space, for storage of epoxy resin composition parts A and B, water, and reflective glass spheres. The equipment must be capable of holding 300-gallons of each color paint and 1800-lbs of glass beads.
3. Capable of simultaneously applying centerline and edgeline markings at the width indicated in solid or broken patterns or various combinations thereof.
4. Equipped with automatic electrically controlled skip line mechanism capable of retracing the existing markings or applying new markings.
5. Equipped with a bead dispenser capable of mechanically conveying glass beads onto the painted surface, at the required application rate, by pressurization or other method not dependent upon gravity.
6. Equipped with at least one steerable gun carriage on the driver's side and at least one on the passenger side.

7. Equipped with a footage counter which automatically and continuously measures the length of each line placed, to the nearest foot. Provide proof of calibration to the engineer upon request.
8. Equipped with usage counter, which quantifies the volume of material placed. Provide proof of calibration to the engineer upon request.
9. Equipped with a hand applicator for use in applying special markings.
10. Equipped with heating mechanism capable of heating part A and part B material to satisfy the manufacturer's recommendations and heating water to a temperature of approximately 140 degrees F.
11. Equipped with temperature gauges that have been calibrated within the past six months. Provide proof of calibration to the engineer upon request.
12. Equipped with a transfer pump system on machine capable of transferring the paint from the shipping containers at a rate of 25 gallons per minute.
13. Equipped with a citizens band transceiver for communication or other approved communication device.
14. Equipped with pressure gauges on each proportioning pump located in an easily visible location.
15. Mobile and maneuverable enough to produce straight lines and standard curves in true arcs.
16. Equipped with DE MUTCD compliant signage.

D. Clean all parts of the equipment of foreign or different colored material prior to introducing a new material batch.

861.3.3 Pavement marking layout.

A. Perform pavement marking layout as needed to ensure accurate placement.

B. Offset longitudinal lines at least 2-inches from longitudinal pavement joints or seams.

C. Offset longitudinal lines at least 2-inches to the inside of shoulder breaks of pavement.

861.3.4 Application.

A. Clean pavement surface of oil, surface treatment, curing compound, dirt, grease, concrete laitance, and other contaminants to a width at least 4-inches wider than the marking to be applied.

B. Ensure ambient and surface temperatures are at least 35 degrees F and rising, and in accordance with the manufacturer's recommendations. If the manufacturer recommended temperature requirement for the pavement marking material application deviates from these specifications, the manufacturer's recommendations shall hold priority. Confirm the atmospheric and pavement surface conditions with the engineer prior to starting work.

C. Place a quality control strip as directed by the engineer at the beginning of each day's operations to demonstrate that the application equipment is working properly and applying markings as required. Repeat the demonstration whenever there is a change in equipment settings or as directed by the engineer when the quality of the line being applied is in question. Authorization to proceed will be given by the engineer when the quality control test indicates conformance. If the application of the control strip is on the actual roadway, correct any application that is not in compliance with the contract.

D. Apply contrast pavement markings consisting of black epoxy flooded with black aggregate in accordance with the contract and the manufacturer's recommendations. Dispense black epoxy at a wet film thickness of 20-mils.

E. Apply white or yellow pavement marking material in accordance with the contract and the manufacturer's recommendations. Apply in accordance with the following provisions unless approved otherwise by the engineer.

1. Apply pavement markings in the general direction of traffic.
2. Apply at an application speed of no more than 10 miles per hour.
3. Dispense epoxy paint at a wet film thickness of 20-mils. Apply glass beads uniformly over the surface using the double drop method with a minimum rate of 12-pounds of Type 1 glass beads and 12-pounds of Type 4 glass beads for a total minimum weight of 24-pounds per gallon of paint applied.
4. All necessary markings shall be installed before the end of the workday. Install the markings as soon as possible after weather interrupts the work.

F. Protect the pavement markings for an adequate time to allow the markings to dry and become track-free using a method approved by the engineer. Follow the manufacturer's recommendations for track-free time.

G. Remove existing pavement markings that conflict with new or altered traffic patterns as well as any layout markings installed that detract from the overall appearance or function of pavement markings in accordance with Section 868.

H. Request engineer to perform retroreflectivity testing once pavement marking at the location is complete.

861.3.5 Evaluation and Correction.

A. The engineer will evaluate the pavement markings for defects after an observation period of 180-days from the date the pavement is opened to traffic. Time charges will not be assessed during the observation period provided all other work is complete. The engineer may waive a portion or all of the 180-day observation period.

B. The engineer will inform the contractor of pavement markings that have failed and that require corrective action.

C. Correct pavement marking defects as directed by the engineer within 30-days of receiving written notification. Examples of pavement marking defects for epoxy pavement marking material include:

1. Insufficient retroreflectivty, glass bead coverage or bead retention.
2. Damage caused by a vehicle tracking over uncured pavement marking material.
3. More than 5 percent exposure of substrate or poor adhesion in any 2000-foot section of longitudinal marking.
4. Discolored marking when compared visually with color chips.
5. Longitudinal marking is more than 2-inches out of place.
6. Insufficient pavement marking thickness.

7. Pavement marking variations more than 3/8-inch from alignment within any 40-foot section of traveled way.

861.4 Method of Measurement.

A. The Department will measure linear pavement markings as the number of linear feet of pavement markings placed and accepted.

861.5 Basis of Payment.

A. The Department will pay the quantity of linear pavement markings at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

ITEM	DESCRIPTION	UNIT
861001	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, 6"	LF
861002	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, 12"	LF
861003	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 3"	LF
861004	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 6"	LF
861005	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 9"	LF
861006	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 10"	LF
861007	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 16"	LF
861008	TEMPORARY PAVEMENT STRIPING, EPOXY RESIN PAINT, 4”	LF
861009	TEMPORARY PAVEMENT STRIPING, EPOXY RESIN PAINT, BLACK, 3”	LF

SECTION 862 – ALKYD TYPE THERMOPLASTIC PAVEMENT MARKINGS

862.1 Description.

This work consists of providing and installing alkyd type thermoplastic pavement markings.

862.2 Materials.

A.	Alkyd type thermoplastic striping	Section 1071.3.1
B.	Glass beads	Section 1071.3.2

862.3 Construction.

862.3.1 Submittals.

A. Submit a schedule of operations for the engineer's approval before starting any pavement marking work. Submit the schedule 2-weeks before the striping application.

862.3.2 Equipment.

A. Provide the engineer access to the application equipment for inspection. Do not commence work until equipment is approved by the engineer.

B. Keep certificate of analysis for pavement marking material being applied by the equipment within a vehicle cabin. Provide the certificate of analysis to the engineer upon request.

C. Use either small equipment or vehicle mounted equipment conforming to the following requirements:

1. Capable of applying approved alkyd thermoplastic pavement marking material in a manner that conforms with the manufacturer's requirements and the requirements of the contract.
2. Equipped with oil or air jacketed kettles for uniform melting and heating of the thermoplastic material, with an automatic thermostatic device to provide positive temperature. The kettles are to conform to the requirements of the National Board of Fire Underwriters (NBFU), the National Fire Protection Association (NFPA), and State and local authorities. Kettles are to be easily accessible for performance of cleaning and maintenance.
3. Capable of continuous mixing and agitation of the material in the kettle. Constructed so that all mixing and conveying parts, including the application apparatus, maintains the material at the specified temperature and constructed to prevent clogging of the applicator conveying parts between the reservoir and the application apparatus.
4. Equipped with temperature gauges that have been calibrated within the past six months. Provide proof of calibration to the engineer upon request.
5. Equipped with a bead dispenser capable of mechanically conveying glass beads onto the painted surface, at the required application rate, by pressurization or other method not dependent upon gravity.

D. Vehicle mounted equipment is to meet the following additional equipment requirements:

1. Capable of holding a minimum of 600-pounds of molten thermoplastic material for long line application.

2. Capable of applying centerline and edgeline markings at the width indicated in solid or broken patterns or various combinations thereof.
3. Mobile and maneuverable enough to produce straight lines and standard curves in true arcs.
4. Equipped with DE MUTCD compliant signage when mobile applications are performed.

E. Clean all parts of the equipment of foreign or different colored material prior to introducing a new material batch.

862.3.3 Pavement marking layout.

A. Perform pavement marking layout as needed to ensure accurate placement.

B. Offset longitudinal lines at least 2-inches from longitudinal pavement joints or seams.

C. Offset longitudinal lines at least 2-inches to the inside of shoulder breaks of pavement.

862.3.4 Application.

A. Clean pavement surface of oil, surface treatment, curing compound, dirt, grease, concrete laitance, and other contaminants to a width at least 4-inches wider than the marking to be applied.

B. Ensure ambient and surface temperatures are at least 50 degrees F and rising, and in accordance with the manufacturer's recommendations. If the manufacturer recommended temperature requirement for the pavement marking material application deviates from these specifications, the manufacturer's recommendations shall hold priority. Confirm the atmospheric and pavement surface conditions with the engineer prior to starting work.

C. Evaluate the bond of the existing thermoplastic material to the existing pavement surface when applying new material over existing thermoplastic material. Remove existing thermoplastic material that is not properly bonded to the existing pavement surface at the direction of the engineer.

D. Place a quality control strip as directed by the engineer at the beginning of each day’s operations to demonstrate that the application equipment is working properly and applying markings as required. Repeat the demonstration whenever there is a change in equipment settings or as directed by the engineer when the quality of the line being applied is in question. Authorization to proceed will be given by the engineer when the quality control test indicates conformance. If the application of the control strip is on the actual roadway, correct any application that is not in compliance with the contract.

E. Apply pavement marking material in accordance with the contract and the manufacturer’s recommendations. Apply in accordance with the following provisions unless approved otherwise by the engineer.

1. Apply pavement markings in the general direction of traffic.
2. Apply at an application speed of no more than 10 miles per hour.
3. Dispense thermoplastic marking material to a thickness of 90-mils for longitudinal lines and 125-mils for transverse lines, symbols, and legends. Uniformly apply glass beads across the surface at a rate of 10-pounds per 100 square feet of marking.

4. All necessary markings shall be installed before the end of the workday. Install the markings as soon as possible after weather interrupts the work.

F. Protect the pavement markings for an adequate time to allow the markings to dry and become track-free using a method approved by the engineer. Follow the manufacturer's recommendations for track-free time.

G. Remove existing pavement markings that conflict with new or altered traffic patterns as well as any layout markings installed that detract from the overall appearance or function of pavement markings in accordance with Section 868.

H. Request engineer to perform retroreflectivity testing once pavement marking at the location is complete.

862.3.5 Evaluation and Correction.

A. The engineer will evaluate the pavement markings for defects after an observation period of 180-days from the date the pavement is opened to traffic. Time charges will not be assessed during the observation period provided all other work is complete. The engineer may waive a portion or all of the 180-day observation period.

B. The engineer will inform the contractor of pavement markings that have failed and that require corrective action.

C. Correct pavement marking defects as directed by the engineer within 30-days of receiving written notification. Examples of pavement marking defects for alkyd type thermoplastic pavement marking material include:

1. Insufficient retroreflectivty, glass bead coverage or bead retention.
2. Damage caused by a vehicle tracking over uncured pavement marking material.
3. More than 5 percent exposure of substrate or poor adhesion in any 2000-feet section of longitudinal marking.
4. Discolored marking when compared visually with color chips.
5. Longitudinal marking is more than 2-inches out of place.
6. Insufficient pavement marking thickness.
7. Pavement marking variations more than 3/8-inch from alignment within any 40-foot section of traveled way.
8. Less than 90 percent of material remaining for each individual symbol, transverse pavement marking, or legends.
9. Pavement marking cracking, bleeding, or staining.

862.4 Method of Measurement.

A. The Department will measure linear pavement markings as the number of linear feet of pavement markings placed and accepted.

B. The Department will measure symbols and transverse pavement markings as the number of square feet placed and accepted. Symbols and transverse pavement markings will be measured in accordance with the following square foot values:

1. Straight arrow symbol 12.50 ft²
2. Left and right arrow symbol 15.50 ft²
3. Combination arrow symbol 20.00 ft²
4. "ONLY" legend 23.00 ft²
5. "SCHOOL" legend 35.00 ft²
6. "STOP" legend 23.50 ft²
7. “AHEAD” legend 40.00 ft²
8. Transverse line, 8-inch 0.66 ft² / linear foot
9. Transverse line, 12-inch 1.00 ft² / linear foot
10. Transverse line, 16-inch 1.33 ft² / linear foot
11. Transverse line, 24-inch 2.00 ft² / linear foot
12. "RXR" railroad crossing symbol 69.00 ft²
13. Left and right 18-foot lane reduction arrow symbol 40.90 ft²

862.5 Basis of Payment.

A. The Department will pay the quantity of linear pavement markings at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

B. The Department will pay the quantity of symbols and transverse pavement markings at the contract unit price per square foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

ITEM	DESCRIPTION	UNIT
862001	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, 4"	LF
862002	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, 6"	LF

862003	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, 10"	LF
862004	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, 12"	LF
862005	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, 16"	LF
862006	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, SYMBOL/LEGEND	SF

SECTION 863 – PREFORMED THERMOPLASTIC PAVEMENT MARKINGS

863.1 Description.

This work consists of providing and installing preformed thermoplastic pavement markings.

863.2 Materials.

A. Preformed Thermoplastic Pavement Marking Section 1071.4

863.3 Construction.

863.3.1 Submittals.

A. Submit a schedule of operations for the engineer's approval before starting any pavement marking work. Submit the schedule 2-weeks before the striping application.

863.3.2 Pavement marking layout.

A. Perform pavement marking layout as needed to ensure accurate placement.

863.3.3 Application.

A. Clean pavement surface of oil, surface treatment, curing compound, dirt, grease, concrete laitance, and other contaminants to a width at least 4-inches wider than the marking to be applied.

B. Ensure ambient and surface temperatures are at least 40 degrees F and rising, and in accordance with the manufacturer's recommendations. If the manufacturer recommended temperature requirement for the pavement marking material application deviates from these specifications, the manufacturer's recommendations shall hold priority. Confirm the atmospheric and pavement surface conditions with the engineer prior to starting work.

C. Apply pavement marking material in accordance with the contract and the manufacturer's recommendations. Apply in accordance with the following provisions unless approved otherwise by the engineer.

1. Protect nearby joint filler, sealant material, and pavement marking material as directed by the engineer before preheating the surface.
2. Uniformly apply surface glass beads as recommended by the manufacturer immediately after application of the markings.
3. All necessary markings shall be installed before the end of the workday. Install the markings as soon as possible after weather interrupts the work.

D. Protect the pavement markings for an adequate time to allow the markings to dry and become track-free using a method approved by the engineer. Follow the manufacturer's recommendations for track-free time.

E. Remove existing pavement markings that conflict with new or altered traffic patterns as well as any layout markings installed that detract from the overall appearance or function of pavement markings in accordance with Section 868.

F. Request engineer to perform retroreflectivity testing once pavement marking at the location is complete.

863.3.4 Evaluation and Correction.

A. The engineer will evaluate the pavement markings for defects after an observation period of 180-days from the date the pavement is opened to traffic. Time charges will not be assessed during the observation period provided all other work is complete. The engineer may waive a portion or all of the 180-day observation period.

B. The engineer will inform the contractor of pavement markings that have failed and that require corrective action.

C. Correct pavement marking defects as directed by the engineer within 30-days of receiving written notification. Examples of pavement marking defects for preformed thermoplastic pavement marking material include:

1. Insufficient retroreflectivty, glass bead coverage or bead retention.
2. Damage caused by a vehicle tracking over uncured pavement marking material.
3. Discolored marking when compared visually with color chips.
4. Insufficient pavement marking thickness.
5. Less than 90 percent of material remaining for each individual symbol, transverse pavement marking, or legends.
6. Pavement marking cracking, bleeding, or staining.

863.4 Method of Measurement.

A. The Department will measure symbols and transverse pavement markings as the number of square feet placed and accepted. Symbols and transverse pavement markings will be measured in accordance with the following square foot values:

1. Straight arrow symbol 12.50 ft^2
2. Left and right arrow symbol 15.50 ft^2
3. Combination arrow symbol 20.00 ft^2
4. "ONLY" legend 23.00 ft^2
5. "SCHOOL" legend 35.00 ft^2
6. "STOP" legend 23.50 ft^2
7. “AHEAD” legend 40.00 ft^2
8. Transverse line, 8-inch 0.66 ft^2 / linear foot
9. Transverse line, 12-inch 1.00 ft^2 / linear foot
10. Transverse line, 16-inch 1.33 ft^2 / linear foot
11. Transverse line, 24-inch 2.00 ft^2 / linear foot
12. "RXR" railroad crossing symbol 69.00 ft^2

13. Left and right 18-foot lane reduction arrow symbol 40.90 ft²

B. The Department will measure bike, shared lane, pedestrian, and accessible parking space marking as the number of square feet placed and accepted. Symbol and legend dimensions per the DE MUTCD as described:

1. Bike symbol helmeted bicyclist symbol with a 2' x 6' arrow symbol.
2. Pedestrian symbol walking pedestrian 4' x 8' with a 2’ x 6’ arrow symbol.
3. Accessible parking space marking 40" x 40".
4. Shared lane marking helmeted bicyclist symbol with 5" W chevrons.

863.5 Basis of Payment.

A. The Department will pay the quantity of symbols and transverse pavement markings at the contract unit price per square foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

B. The Department will pay the quantity of bike, pedestrian, and accessible parking space symbols at the contract unit price per each. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

ITEM	DESCRIPTION	UNIT
863001	PREFORMED RETROREFLECTIVE MARKINGS, ALKYD-THERMOPLASTIC, ACCESSIBLE PARKING SPACE MARKING	EACH
863002	PREFORMED RETROREFLECTIVE MARKINGS, ALKYD-THERMOPLASTIC, BIKE SYMBOL	EACH
863003	PREFORMED RETROREFLECTIVE MARKINGS, ALKYD-THERMOPLASTIC, PEDESTRIAN SYMBOL	EACH
863004	PREFORMED RETROREFLECTIVE MARKINGS, ALKYD-THERMOPLASTIC, SHARED LANE SYMBOL	SF
863005	PREFORMED RETROREFLECTIVE MARKINGS, ALKYD-THERMOPLASTIC, OTHER SYMBOL/LEGEND	SF

SECTION 864 – PREFORMED PAVEMENT MARKING TAPE

864.1 Description.

This work consists of providing and installing preformed pavement marking tape.

864.2 Materials.

A. Preformed Pavement Marking Tape Section 1071.5

864.3 Construction.

864.3.1 Submittals.

A. Submit the following items to the engineer:

1. Submit documentation from the pavement marking tape manufacturer certifying that the contractor is trained to install the pavement marking tape before tape placement starts.
2. Submit documentation for personnel verifying a minimum 5-years of experience in using and placing the material before tape placement starts.
3. Submit a schedule of operations for the engineer’s approval before starting any pavement marking work. Submit the schedule 2-weeks before the striping application.

864.3.2 Pavement marking layout.

A. Perform pavement marking layout as needed to ensure accurate placement. Ensure the marking method used is compatible with the pavement marking tape.

B. Offset longitudinal lines at least 2-inches from longitudinal pavement joints or seams.

C. Offset longitudinal lines at least 2-inches to the inside of shoulder breaks of pavement.

864.3.3 Application.

A. General application requirements.

1. Evaluate the existing pavement surface for placement suitability before performing the work. Notify the engineer of existing permanent markings and of deteriorated pavement surfaces. Perform remedial actions as directed by the engineer.
2. Ensure ambient and surface temperatures are at least 40 F and rising, and in accordance with the manufacturer's recommendations. If the manufacturer recommended temperature requirement for the pavement marking material application deviates from these specifications, the manufacturer's recommendations shall hold priority. Confirm the atmospheric and pavement surface conditions with the engineer prior to starting work.
3. Unless directed otherwise by the engineer, provide a manufacturer’s representative, or qualified personnel, onsite to oversee all operations and to ensure successful installation of markings, to provide training and product information, and to problem solve as directed by the engineer.
4. Place a butt splice at the end of pavement marking tape rolls. Do not overlap tape.

5. Place a quality control strip as directed by the engineer at the beginning of each day's operations to demonstrate that the application equipment is working properly and applying markings as required. Repeat the demonstration whenever there is a change in equipment settings or as directed by the engineer when the quality of the line being applied is in question. Authorization to proceed will be given by the engineer when the quality control test indicates conformance. If the application of the control strip is on the actual roadway, correct any application that is not in compliance with the contract.
6. Apply pavement marking material in accordance with the contract and the manufacturer's recommendations. Apply in accordance with the following provisions unless approved otherwise by the engineer.
    a. Fresh bituminous concrete.
        i. Install using the inlay method during the final rolling in accordance with the manufacturer's recommendations.
        ii. Placement of the final pavement lift is not permitted until the striping crew, pavement marking material, and equipment are on site.
        iii. Inlay the tape into the pavement surface with a finish roller without vibration.
    b. Placement on new PCC pavement.
        i. Apply the marking tape only after the concrete has adequately cured as determined by the engineer.
        ii. Clean pavement surface of oil, surface treatment, curing compound, dirt, grease, concrete laitance, and other contaminants to a width at least 4-inches wider than the marking to be applied.
        iii. Use a surface preparation adhesive or primer as recommended by the manufacturer.
        iv. Apply pavement marking material in accordance with the contract and the manufacturer's recommendations.
    c. Placement on existing pavement.
        i. Clean pavement surface of oil, surface treatment, curing compound, dirt, grease, concrete laitance, and other contaminants to a width at least 4-inches wider than the marking to be applied.
        ii. Use a surface preparation adhesive or primer as recommended by the manufacturer.
        iii. Apply pavement marking material in accordance with the contract and the manufacturer's recommendations.

B. All necessary markings shall be installed before the end of the workday. Install the markings as soon as possible after weather interrupts the work.

C. Remove existing pavement markings that conflict with new or altered traffic patterns as well as any layout markings installed that detract from the overall appearance or function of pavement markings in accordance with Section 868.

D. Request engineer to perform retroreflectivity testing once pavement marking at the location is complete.

864.3.4 Furnish Warranty.

A. Provide the engineer the completed manufacturer's warranty.

B. Provide certification to the engineer that the work was performed in accordance with manufacturer's recommendations.

864.3.5 Evaluation and Correction.

A. The engineer will evaluate the pavement markings for defects after an observation period of 180-days from the date the pavement is opened to traffic. Time charges will not be assessed during the observation period provided all other work is complete. The engineer may waive a portion or all of the 180-day observation period.

B. The engineer will inform the contractor of pavement markings that have failed and that require corrective action.

C. Correct pavement marking defects as directed by the engineer within 30-days of receiving written notification. Examples of pavement marking defects for preformed pavement marking tape include:

1. Insufficient retroreflectivty.
2. Damage caused by a vehicle tracking over uncured pavement marking material.
3. Any substrate beneath in-laid pavement marking tape is exposed due to film loss.
4. More than 5 percent exposure of substrate in any 2000-foot section of longitudinal marking when applied by methods other than the in-laid method.
5. Less than 90 percent of material remaining for each individual symbol, transverse pavement marking, or legends applied by methods other than the in-laid method.
6. Discolored marking when compared visually with color chips.
7. Longitudinal marking is more than 2-inches out of place.
8. Insufficient pavement marking thickness.
9. Pavement marking variations more than 3/8-inch from alignment within any 40-foot section of traveled way.

864.4 Method of Measurement.

A. The Department will measure linear pavement markings as the number of linear feet of pavement markings placed and accepted.

B. The Department will measure symbols and transverse pavement markings as the number of square feet placed and accepted. Symbols and transverse pavement markings will be measured in accordance with the following square foot values:

1. Straight arrow symbol 12.50 ft^2
2. Left and right arrow symbol 15.50 ft^2
3. Combination arrow symbol 20.00 ft^2
4. "ONLY" legend 23.00 ft^2

5. "SCHOOL" legend 35.00 ft²
6. "STOP" legend 23.50 ft²
7. “AHEAD” legend 40.00 ft²
8. Transverse line, 8-inch 0.66 ft² / linear foot
9. Transverse line, 12-inch 1.00 ft² / linear foot
10. Transverse line, 16-inch 1.33 ft² / linear foot
11. Transverse line, 24-inch 2.00 ft² / linear foot
12. "RXR" railroad crossing symbol 69.00 ft²
13. Left and right 18-foot lane reduction arrow symbol 40.90 ft²

C. The Department will measure bike, shared lane, pedestrian, and accessible parking space marking as the number of square feet placed and accepted. Symbol and legend dimensions per the DE MUTCD as described:

1. Bike symbol helmeted bicyclist symbol with a 2' x 6' arrow symbol.
2. Pedestrian symbol walking pedestrian 4' x 8' with a 2’ x 6’ arrow symbol.
3. Accessible parking space marking 40" x 40".
4. Shared lane marking helmeted bicyclist symbol with 5" W chevrons.

864.5 Basis of Payment.

A. The Department will pay the quantity of linear pavement markings at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing a manufacturer’s technical representative;
3. providing and placing all materials;
4. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
5. protecting uncured pavement markings from vehicle damage; and
6. repairing defective work as directed by the Department.

B. The Department will pay the quantity of symbols and transverse pavement markings at the contract unit price per square foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing a manufacturer’s technical representative;
3. providing and placing all materials;
4. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
5. protecting uncured pavement markings from vehicle damage; and
6. repairing defective work as directed by the Department.

C. The Department will pay the quantity of bike, pedestrian, and accessible parking space symbols at the contract unit price per each. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing a manufacturer's technical representative;
3. providing and placing all materials;
4. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
5. protecting uncured pavement markings from vehicle damage; and
6. repairing defective work as directed by the Department.

ITEM	DESCRIPTION	UNIT
864001	PREFORMED RETROREFLECTIVE MARKINGS, PATTERNED, 6"	LF
864002	PREFORMED RETROREFLECTIVE MARKINGS, PATTERNED, 9"	LF
864003	PREFORMED RETROREFLECTIVE MARKINGS, PATTERNED, 10"	LF
864004	PREFORMED RETROREFLECTIVE MARKINGS, PATTERNED, 12"	LF
864005	PREFORMED RETROREFLECTIVE MARKINGS, PATTERNED, 16"	LF
864006	PREFORMED RETROREFLECTIVE MARKINGS, PATTERNED, 9", WITH CONTRAST	LF
864007	PREFORMED RETROREFLECTIVE MARKINGS, PATTERNED, 15", WITH CONTRAST	LF
864008	PREFORMED RETROREFLECTIVE MARKINGS, PATTERNED, SYMBOL/LEGEND	SF
864009	PREFORMED RETROREFLECTIVE MARKINGS, ACCESSIBLE PARKING SPACE MARKING	EACH
864010	PREFORMED RETROREFLECTIVE MARKINGS, BIKE SYMBOL	EACH
864011	PREFORMED RETROREFLECTIVE MARKINGS, PEDESTRIAN SYMBOL	EACH
864012	PREFORMED RETROREFLECTIVE MARKINGS, SHARED LANE SYMBOL	EACH

SECTION 865 – TEMPORARY PAVEMENT MARKING TAPE

865.1 Description.

This work consists of providing and installing temporary pavement marking tape.

865.2 Materials.

A. Temporary Pavement Marking Tape Section 1071.5

865.3 Construction.

A. Submit a schedule of operations for the engineer's approval before starting any pavement marking work. Submit the schedule 2-weeks before the striping application.

B. Perform pavement marking layout as needed to ensure accurate placement.

C. Clean pavement surface of oil, surface treatment, curing compound, dirt, grease, concrete laitance, and other contaminants to a width at least 4-inches wider than the marking to be applied.

D. Ensure ambient and surface temperatures and the relative humidity conforms to the manufacturer's recommendations. Confirm the atmospheric and pavement surface conditions with the engineer prior to starting work.

E. Place a quality control strip as directed by the engineer to demonstrate that the application equipment is working properly and applying markings as required. Repeat the demonstration whenever there is a change in equipment settings or as directed by the engineer when the quality of the line being applied is in question. Authorization to proceed will be given by the engineer when the quality control test indicates conformance. If the application of the control strip is on the actual roadway, correct any application that is not in compliance with the contract.

F. Apply temporary pavement marking tape in accordance with the contract and the manufacturer's recommendations. Apply in accordance with the following provisions unless approved otherwise by the engineer.

1. Apply pavement markings in the general direction of traffic.
2. Apply at an application speed of no more than 10 miles per hour.
3. All necessary markings shall be installed before the end of the workday. Install the markings as soon as possible after weather interrupts the work.

G. Remove existing pavement markings that conflict with new or altered traffic patterns as well as any layout markings installed that detract from the overall appearance or function of pavement markings in accordance with Section 868.

H. Request engineer to perform retroreflectivity testing once pavement marking at the location is complete.

I. The engineer will evaluate the pavement markings for defects after application. Correct pavement marking defects as directed by the engineer.

865.4 Method of Measurement.

A. The Department will measure linear pavement markings as the number of linear feet of pavement markings placed and accepted.

B. The Department will measure symbols and transverse pavement markings as the number of square feet placed and accepted. Symbols and transverse pavement markings will be measured in accordance with the following square foot values:

1. Straight arrow symbol 12.50 ft²
2. Left and right arrow symbol 15.50 ft²
3. Combination arrow symbol 20.00 ft²
4. "ONLY" legend 23.00 ft²
5. "SCHOOL" legend 35.00 ft²
6. "STOP" legend 23.50 ft²
7. “AHEAD” legend 40.00 ft²
8. Transverse line, 8-inch 0.66 ft² / linear foot
9. Transverse line, 12-inch 1.00 ft² / linear foot
10. Transverse line, 16-inch 1.33 ft² / linear foot
11. Transverse line, 24-inch 2.00 ft² / linear foot
12. "RXR" railroad crossing symbol 69.00 ft²
13. Left and right 18-foot lane reduction arrow symbol 40.90 ft²

C. The Department will measure bike, shared lane, pedestrian, and accessible parking space marking as the number of square feet placed and accepted. Symbol and legend dimensions per the DE MUTCD as described:

1. Bike symbol helmeted bicyclist symbol with a 2' x 6' arrow symbol.
2. Pedestrian symbol walking pedestrian 4' x 8' with a 2’ x 6’ arrow symbol.
3. Accessible parking space marking 40" x 40".
4. Shared lane marking helmeted bicyclist symbol with 5" W chevrons.

865.5 Basis of Payment.

A. The Department will pay the quantity of linear pavement markings at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

B. The Department will pay the quantity of symbols and transverse pavement markings at the contract unit price per square foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;
2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

Item	Description	Unit
865001	TEMPORARY MARKINGS, TAPE, 4"	LF
865002	TEMPORARY MARKINGS, TAPE, 6"	LF
865003	TEMPORARY MARKINGS, TAPE, 10"	LF
865004	TEMPORARY MARKINGS, TAPE, 12"	LF
865005	TEMPORARY MARKINGS, TAPE, SYMBOL/LEGEND	SF
865006	TEMPORARY MARKINGS, TAPE, ACCESSIBLE PARKING SPACE MARKING	EACH
865007	TEMPORARY MARKINGS, TAPE, PEDESTRIAN SYMBOL	EACH
865008	TEMPORARY MARKINGS, TAPE, BIKE SYMBOL	EACH
865009	TEMPORARY MARKINGS, TAPE, SHARED LANE SYMBOL	EACH

SECTION 866 – BLACKOUT PAVEMENT MARKING TAPE

866.1 Description.

This work consists of providing, installing, and removing blackout pavement marking tape.

866.2 Materials.

A. Blackout Pavement Marking Tape Section 1071.7

866.3 Construction.

A. Submit a schedule of operations for the engineer's approval before starting any pavement marking work. Submit the schedule 2-weeks before the striping application.

B. Perform pavement marking layout as needed to ensure accurate placement.

C. Clean pavement surface of oil, surface treatment, curing compound, dirt, grease, concrete laitance, and other contaminants to a width at least 4-inches wider than the marking to be applied.

D. Ensure ambient and surface temperatures and the relative humidity conforms to the manufacturer's recommendations. Confirm the atmospheric and pavement surface conditions with the engineer prior to starting work.

E. Apply blackout pavement marking tape in accordance with the contract and the manufacturer's recommendations. Do not apply blackout tape on Portland cement concrete pavement. Apply in accordance with the following provisions unless approved otherwise by the engineer.

1. Apply pavement markings in the general direction of traffic.
2. Apply at an application speed of no more than 10 miles per hour.
3. All necessary markings shall be installed before the end of the workday. Install the markings as soon as possible after weather interrupts the work.

F. Remove existing pavement markings that conflict with new or altered traffic patterns as well as any layout markings installed that detract from the overall appearance or function of pavement markings in accordance with Section 868.

G. The engineer will evaluate the pavement markings for defects after application. Correct pavement marking defects as directed by the engineer.

866.4 Method of Measurement.

A. The Department will measure blackout pavement markings as the number of linear feet of pavement markings placed and accepted.

866.5 Basis of Payment.

A. The Department will pay the quantity of linear pavement markings at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Performing pavement marking layout work;

2. providing and placing all materials;
3. preparing pavement, including sandblasting, sweeping, and cleaning or removal of curing compound on PCC pavement;
4. protecting uncured pavement markings from vehicle damage; and
5. repairing defective work as directed by the Department.

ITEM	DESCRIPTION	UNIT
866001	TEMPORARY MARKINGS, TAPE, BLACKOUT, 6"	LF
866002	TEMPORARY MARKINGS, TAPE, BLACKOUT, 8"	LF
866003	TEMPORARY MARKINGS, TAPE, BLACKOUT, 12”	LF

SECTION 867 – SNOWPLOWABLE RAISED PAVEMENT MARKERS

867.1 Description.

This work consists of providing, installing, replacing, and removing snowplowable raised pavement markers.

867.2 Materials.

A.	Raised or Recessed Pavement Marker	Section1071.8.1
B.	Epoxy Resin Adhesive	Section 1071.8.2

867.3 Construction.

867.3.1 Installation of new pavement markers:

A. Before installing, layout the pavement marker locations.

B. Saw cut the pavement to match the bottom contour of the marker housing:

1. Use only truck mounted saw cutting equipment.
2. Cut a slot deep enough to set the housing in epoxy with leveling lugs resting on the pavement surface so that the front edge of the marker is at or below the pavement surface.
3. Repair excessive saw cuts to the satisfaction of the engineer.

C. Ensure air temperature and surface temperature at the time of application are in accordance with the epoxy resin adhesive manufacturer's recommendations.

D. Perform slot cleaning to remove loose material as recommended by the epoxy resin adhesive manufacturer.

E. Install the epoxy and pavement marker in the prepared contour slot in accordance with the manufacturer's recommendations. When the housing is installed, the epoxy should completely fill voids between the housing and the road surface.

867.3.2 Installation of replacement lens:

A. Remove the existing pavement marker lens from the housing.

B. Clean the housing as recommended by the manufacturer.

C. Install replacement lens according to the manufacturer's recommendations.

867.3.3 Pavement marker removal:

A. Remove the pavement marker in a method that will cause the least damage to the pavement structure and is approved by the engineer.

B. Repair any pavement damage caused by removal to the satisfaction of the engineer.

867.4 Method of Measurement.

A. The Department will measure pavement markers as the number of each pavement marker installed, replaced, or removed and accepted.

867.5 Basis of Payment.

A. The Department will pay for the quantity of pavement markers installed at the contract unit price per each. Price and payment constitute full compensation for:

1. Performing pavement marker layout work;
2. providing all materials;
3. saw-cutting;
4. cleaning;
5. installing;
6. discarding existing material; and
7. repairing excessive saw cuts.

B. The Department will pay for the quantity of pavement marker lenses replaced at the contract unit price per each. Price and payment constitute full compensation for:

1. Removing existing pavement marker lens from the housing;
2. providing all materials;
3. cleaning;
4. installing; and
5. discarding existing material.

C. The Department will pay for the quantity of pavement marker removal at the contract unit price per each. Price and payment constitute full compensation for:

1. Removing pavement markers;
2. discarding existing material; and
3. restoring existing pavement.

ITEM	DESCRIPTION	UNIT
867001	SNOWPLOWABLE RAISED PAVEMENT MARKER	EACH
867002	SNOWPLOWABLE RAISED PAVEMENT MARKER, REMOVAL, HOUSING	EACH
867003	SNOWPLOWABLE RAISED PAVEMENT MARKER, REMOVAL, LENS	EACH
867004	SNOWPLOWABLE RAISED PAVEMENT MARKER, REPLACEMENT, LENS	EACH

SECTION 868 – PAVEMENT MARKING REMOVAL

868.1 Description.

This work consists of removing pavement marking material from a roadway surface.

868.2 Materials.

NONE

868.3 Construction.

A. Take care to remove pavement marking material in a manner that does not damage the existing pavement surface.

1. Use shot or abrasive grit blasting or water blasting equipment to remove latex marking paint and epoxy resins.
2. Use burning or grinding erasing machines, instead of shot or abrasive grit blasting or water blasting, for removing alkyd thermoplastic markings, temporary marking tape, or preformed marking tape.

B. Collect and dispose of all shot and abrasive grit and pavement marking materials removed from the pavement surface. Do not wash or sweep such material to the roadside.

C. Repair any pavement or surface damage caused during the removal process to the satisfaction of the engineer.

D. Use an approved flat black paint or asphalt sealer to cover exposed aggregate or embedded paint that remain after removing striping on bituminous concrete.

1. If grit blasting or water blasting is used to remove the pavement marking, use a flat black paint to cover any exposed aggregate or embedded paint.
2. If a grinding erasing machine was used to remove the pavement marking, use an asphalt sealer to cover exposed aggregate or embedded paint.

868.4 Method of Measurement.

A. The Department will measure pavement marking removal as the number of square feet removed and accepted.

868.5 Basis of Payment.

A. The Department will pay the quantity of pavement marking removal at the contract unit price per square foot. Price and payment constitute full compensation for:

1. Performing pavement marking removal;
2. performing collection and disposal of removed materials;
3. repairing damaged pavement surfaces caused by removal; and
4. covering exposed aggregate or remaining paint with flat blank paint or asphalt sealer.

ITEM	DESCRIPTION	UNIT

868001	PAVEMENT MARKING, REMOVAL	SF
868002	PAVEMENT MARKING TAPE, REMOVAL	SF

DIVISION 900 — EROSION, SEDIMENT, AND STORMWATER MEASURES

SECTION 901 — EROSION, SEDIMENT, AND STORMWATER MANAGEMENT

901.1 Description.

This work consists of implementing erosion and sediment control and stormwater management practices and techniques.

901.1.1 Definitions.

A. Daily Oversight – Review of project limits and guidance of construction personnel involved in land disturbing activities.

B. Disturbed Area – An area where the contractor has disturbed the land, while performing the work, and that may result in accelerated stormwater runoff and soil erosion.

C. Erosion, Sediment, and Stormwater Management (ES2M) Inspections – Compliance inspections of the project site.

D. ES2M Certified Construction Site Reviewer (CCR) – An inspector of sediment and stormwater controls certified by the Department of Natural Resources and Environmental Control (DNREC) and as appointed by the engineer.

E. Responsible Person – A foreman or superintendent in charge of on-site clearing and land disturbing activities and for sediment and stormwater control.

F. Sediment and Stormwater Management Plan – The plan contained in the contract describing the control of soil erosion, sedimentation, stormwater quantity, and water quality impacts resulting from land disturbing activities on the project.

G. Stormwater Pollution Prevention Plan (SWPPP) – The pollution prevention notes and details contained in the Sediment and Stormwater Management Plan.

901.2 Materials.

Not applicable.

901.3 Construction.

901.3.1 Legal Authority.

A. Comply with:

1. Chapters 40 and 60 of Title 7 of the Delaware Code;
2. Title 7 Natural Resources and Environmental Control Delaware Administrative Code 7201 Regulations Governing Control of Water Pollution, Section 9;
3. Title 7 Natural Resources and Environmental Control Delaware Administrative Code 5101 Sediment and Stormwater Regulations; and
4. The NPDES General Permit Program for Stormwater Discharges Associated with Construction Activities.
5. https://dnrec.alpha.delaware.gov/watershed-stewardship/sediment-stormwater/

901.3.2 Contractor Responsibility.

A. Install and maintain Stormwater Management Facilities and Post-Construction Stormwater Management systems in accordance with the Sediment and Stormwater Management Plan.

B. Comply with the requirements of Chapter 60 of Title 7 including the current Delaware Construction General Permit.

C. Provide documentation to certify that the responsible person, defined in Section 901.1.E., successfully completed the DNREC Contractor Training Program (Blue Card) before beginning land disturbing activities.

D. Ensure that the responsible person oversees implementation of the Sediment and Stormwater Management Plan and provides daily oversight and guidance to construction personnel during land disturbing activities.

E. Provide property owner consent and an approved Erosion & Sediment Control Plan prior to use of offsite stockpiling.

F. The contractor may be subject to violations or fines received from regulatory agencies as a result of site conditions.

G. Co-Permitting

1. For contracts involving land disturbing activities subject to the provisions of Section 901.3.1, file as a Co-Permittee on the original Notice of Intent under DNREC''s Construction General Permit for the project. File as a Co-Permittee after receipt of the contract award notice as a condition of contract execution. Upon contract execution, assume responsibility for implementing and complying with the approved Sediment and Stormwater Management Plan.
2. In accordance with DNREC's Construction General Permit, install notice of permit coverage as directed by the engineer. The notice will be legible, publicly accessible, and protected from the weather. Posting of permit coverage and maintenance is incidental to the contract.
3. Co-Permittee permit coverage will not be terminated until final stabilization has been accepted by the Department and the Division of Maintenance and Operations has issued the final project acceptance letter. Permit fees are annual, charged on July 1.

H. Designate a certified Erosion & Sediment Control (ESC) supervisor who:

1. Is a foreperson or superintendent;
2. is the responsible person for land disturbing activities;
3. provides daily oversight and guidance for implementing and maintaining the Sediment and Stormwater Management Plan, corrects deficiencies, and coordinates deviations from the approved plan for redline plan preparation and approval;
4. completes the required daily Erosion & Sediment Control oversight;
5. accompanies DelDOT's ES2M CCR on ES2M Inspections;
6. attends the Erosion and Sediment pre-construction meeting, if held, and exchanges contact information with the ES2M CCR;
7. possesses and maintains a DNREC certified Blue Card or a DNREC certified CCR card for the project duration; and

8. contacts the ES2M CCR a minimum of 48 hours before land disturbing activities begin to schedule an initial inspection of perimeter controls for the next phase.

901.3.3 Maintain Erosion and Sediment Control Measures.
Maintain erosion and sediment control items continuously throughout the project duration, including periods when the project is inactive or suspended. Repair, replace, or maintain erosion and sediment control devices promptly as noted during the ES2M Inspection or as directed by the engineer. Maintain erosion and sediment control devices until construction phasing or stabilization allow the removal of those controls as determined by the engineer.

901.3.4 Failure to Implement or Maintain Erosion and Sediment Control Measures.
If the contractor fails to perform the work as described in the approved Sediment and Stormwater Management Plan, the ES2M Report, or in writing from the engineer, the engineer may take any or all of the actions described in Sections 105.1 and 105.13, including suspending all or part of the work, withholding progress payments, or performing maintenance with DelDOT forces, or third party forces, and deducting the costs from monies due or to become due to the contractor.

901.3.5 Fines Resulting from Non-Compliance.
If the DNREC, the Army Corps of Engineers, or the EPA fine the Department as a result of the contractor's failure to implement and maintain the Sediment and Stormwater Management Plan and SWPPP, the Department will require the contractor to pay the fines directly or the Department will deduct the fines from monies due the contractor.

901.4 Method of Measurement.

The Department will not measure this item.

901.5 Basis of Payment.

The Department will consider costs associated with the provisions in this Section 901 as incidental to the contract.

SECTION 902 — PUMPING OR DEWATERING OPERATIONS

902.1 Description.

A. Statewide General Permit for Minor Dewatering Activities

1. Comply with the Statewide General Permit issued to the Department by DNREC via the interagency Memorandum of Agreement. Covered work includes the following activities:

a. Dewatering.

i. Dewater the work area in accordance with this specification at rates less than 50,000 gallons per day.

b. Stream By-pass Pumping.

i. 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

1. Obtain a separate dewatering permit from DNREC when groundwater or surface water withdrawal rates in excess of 50,000 gallons per day are necessary.

a. Permit Acquisition

i. 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.

b. Permit Acquisition Time

i. 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.

c. Other Permits.

i. State and Federal permits are required for any entry into streams or wetlands. Environmental requirements are more fully described in the Project Environmental Statement.

ii. 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 107.2.

d. Licensing Requirements.

i. 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.

902.2 Material.

Provide materials as necessary and required.

902.3 Construction.

A. Submit approved permits

1. Submit copies of all permit approvals to the engineer. Dewatering operation cannot begin until the necessary dewatering permit is submitted to the engineer.

B. Dewatering Equipment

1. 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.

C. Required Notifications

1. Notify the DNREC Water Supply Section at (302) 739-9945, 48-hours prior to starting any dewatering operations.
2. 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.

D. Dewatering Operation

1. 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.

E. Protection of Work Area

1. 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.

F. Protect Adjacent Property

1. 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.

G. Protect Adjacent Waterbodies

1. Discharge of saline water into a fresh water system or discharge of 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.

H. Dewatering Discharge

1. 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.

I. Dewatering of Temporary Cofferdams for Bridge Construction.

1. 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.

J. Well Impacts.

1. 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.

902.4 Method of Measurement.

Pumping or Dewatering operations will not be separately measured.

902.5 Basis of Payment.

A. Pumping or Dewatering operations will not be separately paid. All costs are incidental to the associated work items.

B. Permit costs will not be separately paid for the acquisition of separate dewatering permits from DNREC.

SECTION 903 — POLLUTION PREVENTION

903.1 Description.

This work consists of implementing and maintaining the pollution prevention plan outlined in the contract.

903.2 Materials.

Not applicable.

903.3 Construction.

903.3.1 Application Law and Regulations.
Follow the Delaware Erosion and Sediment Control Handbook.
https://dnrec.alpha.delaware.gov/watershed-stewardship/sediment-stormwater

903.3.2 Prohibited Discharges.

A. Wastewater from concrete washout operations, unless managed by an appropriate control;

B. Wastewater from stucco washout, paint, form release oils, curing compounds, and other construction materials, unless managed by an appropriate control;

C. Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance;

D. Soaps, solvents, or detergents used in vehicle and equipment washing; and

E. Toxic or hazardous substances from a spill or other release.

903.3.3 Maintenance.

A. Inspect pollutant-generating activities and the pollution prevention Best Management.

1. Immediately upon discovery of spilled pollutants, initiate clean-up operations.

2. Do not hose down surfaces, use dry clean-up methods only.

903.4 Method of Measurement.

Not applicable.

903.5 Basis of Payment.

The Department will consider the cost of pollution prevention as incidental to the associated work items. The Department will make no separate payment for pollution prevention activities.

SECTION 905 — SEDIMENT TRAPPING DEVICES

905.1 Description.

This work consists of constructing facilities to trap sediment before it leaves the job site.

905.2 Materials.

A. Silt Fence

1. Wood	Section 1041
2. Geotextile	Section 1060

B. Reinforced Silt Fence

1. Wood	Section 1041
2. Geotextile	Section 1060
3. 2” x 4”, 14 Gage Wire Mesh	

C. Sediment Trap

1. Stone; Delaware No. 3	Section 1004
2. Riprap	Section 1006
3. Wood	Section 1041
4. Compost Filter Log	Section 907.2.C

D. Inlet Sediment Control, Drainage Inlet

1. Geotextile	Section 1060
2. Fence	Section 1061
3. Steel Posts	Section 1039

E. Inlet Sediment Control, Curb Inlet

1. Geotextile	Section 1060
1. Compost Filter Log	Section 907.2.C

E. Inlet Sediment Control, Culvert Inlet

1. Stone; Delaware No. 3	Section 1004
2. Riprap	Section 1006
3. Wood	Section 1041
4. Compost Filter Log	Section 907.2.C
5. Geotextile	Section 1060

A. Super Silt Fence

1. Steel Posts	Section 1039
2. Geotextile	Section 1060

3. Fence Section 1061

905.3 Construction.

A. Direct stormwater runoff from disturbed areas to an approved sediment control measure before releasing the runoff from the project limits. Inspect weekly and immediately after every rainfall to maintain and make repairs as needed. Use the following sediment trapping devices.

B. Silt Fences:

1. Silt fence

a. Place fence in accordance with the Standard Construction Details.

b. Install a reinforcement strip at the geotextile roll ends.

c. Overlap geotextile a minimum of 6-inches at post locations.

d. On slopes, turn the terminal ends of silt fence upslope enough to eliminate flow around the ends of the silt fence.

e. Do not construct the silt fence across ditches, swales, or other areas of concentrated water flow.

2. Reinforced silt fence

Place fence in accordance with the Standard Construction Details and Section 905.3.A. Fasten wire mesh to the posts between the geotextile and the posts.

3. Super Silt Fence

Place fence in accordance with the Standard Construction Details and Section 905.3.A. Fasten geotextile to chain link fence with ties spaced every 24-inches at the top and midsection.

4. Maintenance

a. Repair or replace damaged geotextile until the silt fence is no longer necessary as determined by the engineer.

b. Replace deteriorated or clogged geotextile as directed by the engineer.

c. Remove trapped sediment when the sediment reaches 50 percent of the exposed height of the geotextile.

5. Silt Fence Removal

a. Remove the silt fence, and all materials incidental to silt fence construction, when the engineer determines that the fence is no longer required.

b. Restore areas affected by the silt fence construction to the original or plan contours.

c. Stabilize areas affected by the silt fence construction in accordance with Section 908.

C. Sediment Trap

1. Construct sediment traps by excavating to the dimensions and elevations indicated on the contract and the Standard Construction Details.

2. Stabilize the side slopes with temporary seed in accordance with Section 908.

3. Notify the engineer of conflicts between sediment traps and permanent features to obtain an alternate design for sediment trap locations.
4. Do not excavate sediment traps deeper than 4-feet. Excavate sediment traps having proposed bottom elevations greater than 4-feet below the original grade in stages concurrent with the roadway excavation.
5. Mark the cleanout elevation as 1/2 the design depth of the trap.
6. All traps require an outfall.
7. Sediment trap maintenance:
   a. Maintain the sediment trap to the original dimensions and function.
   b. Remove accumulated sediment when the sediment reaches the cleanout elevation.
   c. Dispose of sediment.
   d. Restore the trap to its plan dimensions and elevations.
8. Sediment trap removal:
   a. Remove the sediment trap when the contributing drainage area is stabilized at a density of 70 percent as determined by the engineer.
   b. Stabilize affected areas in accordance with Section 908.

D. Inlet sediment control:

1. Provide and place inlet sediment controls, selected from the approved products list (https://deldot.gov/Business/drc/index.shtml?dc=stormwater). Construct inlet sediment control according to the type required and follow the applicable Standard Construction Details or the manufacturer's recommendations, whichever is more stringent.
2. Inlet sediment control maintenance:
   a. Remove accumulated sediment upon discovery.
   b. Remove and replace sediment control materials based on the material manufacturer's requirements or when sediments interfere with the flow of water through the material.
   c. Do not allow sediment discharges into bodies of water, ditches, swales, or wetlands that are state, federal, or privately owned.
3. Inlet sediment control removal:
   a. Remove the inlet sediment control when the engineer determines that it is no longer required.
   b. Stabilize affected areas in accordance with Section 908.

905.4 Method of Measurement.

A. The Department will measure:

1. The quantity of silt fence, reinforced silt fence, and super silt fence as the linear feet of fence placed and accepted. The Department will not include overlap in the measurement.

2. Sediment traps as the number of cubic yards of material excavated to construct the sediment traps. The Department will compute the volume of excavated material using the actual dimensions and elevations of the sediment traps constructed as shown in the contract.
3. The quantity of inlet sediment control as each placed and accepted.

B. The Department will not measure sediment trapping device maintenance.

905.5 Basis of Payment.

A. The Department will pay the quantity of silt fence, reinforced silt fence, and super silt fence at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Providing all materials;
2. excavating, backfill, and backfilling;
3. installing;
4. temporary stabilization;
5. removal;
6. site restoration; and
7. permanent stabilization.

B. The Department will pay the quantity of sediment traps at the contract unit price per cubic yard. Price and payment constitute full compensation for:

1. Providing all materials;
2. excavating, backfill, and backfilling;
3. establishing outfalls;
4. installing;
5. temporary stabilization;
6. removal;
7. site restoration; and
8. permanent stabilization.

C. The Department will pay the quantity of inlet sediment control at the contract unit price for each. Price and payment constitute full compensation for:

1. Providing all materials;
2. excavating, backfill, and backfilling;
3. installing;
4. establishing outfalls;
5. temporary stabilization;
6. removal;
7. site restoration; and permanent stabilization.

D. The Department will consider maintenance of the devices, including sediment removal, as 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	EACH
905005	INLET SEDIMENT CONTROL, CURB INLET	EACH
905006	INLET SEDIMENT CONTROL, CULVERT INLET	EACH
905007	SUPER SILT FENCE	LF

SECTION 906 — DEWATERING PRACTICES

906.1 Description.

This work consists of dewatering work sites.

906.2 Materials.

A. Portable Sediment Tank. Provide materials for portable sediment tanks as follows:

1. Wire Mesh - 23-gauge wire steel or galvanized welded wire reinforcement with openings 1/4-inch by 1/4-inch.
2. Corrugated Metal Pipe
3. Geotextile Section 1060
4. Fasteners ASTM F541, Type 1 or Type 2
5. Metal Plate - 1/2-inch thick

B. Approved equal sediment tank

C. Dewatering Bag.

Use in accordance with the manufacture's recommendations with a performance requirement retaining soil particles on a #80 sieve, 177 microns.

D. Sump Pit.

1. Coarse Aggregate, No. 57 Stone Section 1004
2. Corrugated Metal Pipe
3. Geotextile Section 1060
4. Wire Mesh – 23-gauge steel or galvanized welded wire reinforcement with openings 1/4-inch by 1/4-inch.
5. Approved equal sump pit

E. Skimmer dewatering device

1. Coarse Aggregate, No. 57 Stone Section 1004
2. Pipe Culverts, PVC Section 1031
3. Reinforcing Steel Section 1037

F. Well Point System

1. Coarse Aggregate Section 1004
2. Pipe Culverts Section 1031
3. Reinforcing Steel Section 1037

906.3 Construction

A. Trap and filter water produced by dewatering activities. Pump to a suitable discharge area. Trap and retain sediment before discharging water into drainage ways, adjoining properties, and rights-of-way below a project site.

B. Use dewatering practices shown in the contract. If the contract or the engineer do not specify a specific dewatering practice, use a dewatering practice listed below that is appropriate for the specific situation. The engineer's approval is needed to use dewatering practices not included in this list.

C. Inspect weekly and immediately after every rainfall to maintain and make repairs as needed.

D. Portable Sediment Tank

1. Construction

a. Construct the portable sediment tank according to the Standard Construction Details. Construct an approved equal portable sediment tank in accordance with the manufacturer's instructions.

i. The maximum allowable pump discharge of the typical portable sediment tank is 125 gallons per minute.

b. Locate the tank on a level surface and in an area where the tank will cause minimal interference with construction activities, and vehicular and pedestrian traffic.

c. Obtain the engineer's approval to locate the portable sediment tank at a different location, within the LOC, than what is shown in the contract.

d. Construct watertight welds.

e. Fasten the wire mesh and geotextile to the pipe.

2. Maintenance

a. Remove sediment when it accumulates to a depth of 1/3 of the portable sediment tank height.

b. Remove and replace the filter geotextile when:

i. It allows the portable sediment tank to exceed the maximum allowable discharge flow rate of 125 gallons per minute;

ii. when there is a tear; and

iii. when directed by the engineer.

c. Dispose of all sediment collected in the portable sediment tank in an approved disposal area.

3. Removal

a. After removal, grade the area to match the contours shown in the contract. If no contours are shown, match the grades that existed before construction of the tank.

b. Stabilize areas affected by the portable sediment tank in accordance with Section 908.

E. Dewatering Bag

1. Construction

a. Place dewatering bags at locations designated in the contract in accordance with the manufacture's recommendations, or as approved by the engineer.

b. Maintain a water-tight connection.

c. Secure in place.

d. Do not exceed the manufacturer's recommended flow rate or capacity.

e. Discharge the dewatering effluent without causing erosion. The engineer will approve the types of erosion control measures if needed.

2. Maintenance

Provide and place a new dewatering bag in accordance with the manufacture's recommendations or as determined by the engineer.

3. Dewatering Bag Removal

a. Remove and dispose of a dewatering bag when replaced or when no longer needed.

b. Regrade the area to match the contours shown in the contract. If no contours are shown, match the grades that existed before dewatering bag construction.

c. Stabilize areas affected by the dewatering bag in accordance with Section 908.

F. Sump Pit.

1. Construction

a. Excavate the sump pit according to the dimensions in the Standard Construction Details or in accordance with the manufacture's recommendations.

b. Place the layer of stone in the bottom of the sump pit in accordance with the Standard Construction Details. Place the stationary pipe with a bottom cap on top of the bottom layer of stone.

c. Place the removable pipe inside of the stationary pipe in accordance with the Standard Construction Details. Extend both pipes to the same height and a minimum of 12 inches above the lip of the sump pit.

d. Backfill the sump pit with stone.

e. Slope the stone to meet the height of the pipes.

2. Maintenance

When clogged with sediment, replace the geotextile and, if applicable, the wire mesh on the removable pipe and bottom cap.

3. Removal

a. Remove the sump pit and regrade the area to match the contours shown in the contract. If the contract does not show contours, match the grades that existed before construction of the sump pit.

b. Stabilize all areas affected by the sump pit, if needed, in accordance with Section 908.

G. Skimmer Dewatering Device

1. Construction

Construct skimmer dewatering devices in accordance with the dimensions in the Standard Construction Details and place at the locations shown in the contract.

2. Maintenance

   Maintain the skimmer dewatering device in proper operational condition while required on the project.

3. Removal

   Remove the skimmer dewatering device from the project site when directed by the engineer.

H. Well Point System

A typical well point system consists of a series of small diameter wells connected via a header pipe to the suction side of a suitable well point pump.

1. Construction

   a. Design a well point system capable of controlling groundwater in order to install proposed structures on a dry and stable sub-base. Select a location for installing the well point system that will not interfere with construction of the proposed structure until removal is appropriate. If inclusion of the well point system in the work area requires modifications to construction phasing, include the modifications in the shop drawings.

   b. Obtain and comply with all necessary permits in accordance with Section 902. Obtain permits and provide copies to the engineer before beginning excavation.

   c. Install and test the well point system in accordance with the approved design to demonstrate the system's effectiveness to the engineer’s satisfaction before continuing with the excavation.

   d. Modify the well point system if it cannot maintain the groundwater elevation required to provide a dry and stable sub-base.

2. Maintenance

   Maintain the well point system to ensure working order and continuous drawdown throughout the dewatering process.

3. Removal

   a. Remove the well point system after placement of all proposed structures and backfill affected by groundwater conditions, or as directed by the engineer.

   b. Stabilize areas affected by the well point system, if needed, in accordance with Section 908.

906.4 Method of Measurement.

A. The Department will measure the quantity of dewatering work completed and accepted as follows:

1. Portable sediment tanks by each placed and accepted.
2. Dewatering bag by each placed and accepted.
3. Sump pit by each placed and accepted.
4. Skimmer dewatering device by each constructed, placed and accepted.

B. The Department will not measure the well point system.

906.5 Basis of Payment.

A. The Department will pay the quantities of dewatering practices at the contract unit prices for each acceptably placed. The Department will pay for new dewatering bags using the unit cost of item 906002, dewatering bag. Price and payment constitute full compensation for:

1. Providing all materials;
2. fabricating;
3. excavating, backfill, and backfilling;
4. installing;
5. maintaining and sediment removal;
6. temporary stabilization;
7. relocating within project limits;
8. removal;
9. restoring the site; and
10. permanent stabilization.

B. The Department will pay the quantity of well point system as a lump sum. Price and payment will constitute full compensation for:

1. Design;
2. Permits;
3. Installation;
4. Operation;
5. maintenance;
6. removal;
7. restoring the site; and
8. permanent stabilization.

C. The Department will consider re-design or modification of the well point system as incidental to this item;

ITEM	DESCRIPTION	UNIT
906001	PORTABLE SEDIMENT TANK	EACH
906002	DEWATERING BAG	EACH
906003	SUMP PIT	EACH
906004	SKIMMER DEWATERING DEVICE	EACH
906006	WELL POINT SYSTEM	LS

SECTION 907 — WATER CONTROL PRACTICES

907.1 Description.

This work consists of water control practices.

907.2 Materials.

A. Stone Check Dam

1. Stabilization	Section 908
2. Riprap	Section 1006
3. Geotextile	Section 1060

B. Temporary Slope Drain

1. Stabilization	Section 908
2. Riprap	Section 1006
3. Pipe Culvert	Section 1031
4. Wood	Section 1041

C. Compost Filter Log

1. In accordance with the DNREC's Delaware Erosion and Sediment Control Handbook. (https://dnrec.alpha.delaware.gov/watershed-stewardship/sediment-stormwater/)
   a. Filter Sock - 5-millimeter biodegradable HDPE material, 18-inch minimum diameter.

907.3 Construction.

A. Inspect weekly and immediately after every rainfall to maintain and make repairs as needed.

B. Check Dam

1. Stone
   a. Construction

      Construct the stone check dam perpendicular to the flow in sections of the swale or channel. Place riprap to completely cover the channel width. Construct the top of the stone check dam with the center lower than the outer edges in accordance with the Standard Construction Details.

   b. Maintenance
      i. Repair damage from washouts, construction traffic, or silt accumulation among the riprap or whenever the stone check dam ceases to function as intended.
      ii. Remove sediment from behind the check dams when it has accumulated to 50 percent of the original height of the stone check dam at the spillway.
   c. Removal
      i. Remove temporary stone check dams only when directed by the engineer.
      ii. Remove all riprap.

iii. Stabilize disturbed areas in accordance with Section 908 immediately after removing the check dams.

2. Compost Filter Log

a. Construction

Construct the compost filter log check dam perpendicular to the flow in sections of the swale or channel. Place the compost filter log to completely cover the width of the channel. Place the ends of the compost filter log along the banks of the swale or channel with the center lower than the outer edges as shown on Standard Construction Detail.

b. Maintenance

i. Repair damage from washouts, construction traffic, or silt accumulation among the logs or whenever the compost filter log ceases to function as intended.

ii. Remove sediment from behind the check dams when it has accumulated to 50 percent of the original height of the check dam at the spillway.

c. Removal

i. Remove temporary check dams only when directed by the engineer.

ii. Stabilize disturbed areas, in accordance with Section 908, immediately after removing the check dams.

C. Temporary Slope Drain

1. Construction

a. Install, grade, shape, and prepare embankment slopes, edge berms, and interceptor berms in accordance with the contract and the Standard Construction Details.

b. Install a 15-inch pipe for a maximum drainage area of 1-acre.

c. Construct flexible pipe drains in accordance with Section 601. Provide flexible slope drains with potential for length changes to adjust to the interim elevations. Fasten slope drains to the slope. Construct and install a plywood anti-seep collar as shown in the Standard Construction Details. 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 empties into a sediment trap or basin, ensure that it discharges at the riser crest or weir elevation.

d. Construct riprap aprons in accordance with Section 707. Place the apron below the pipe outlet. Provide a riprap apron in accordance with the Standard Construction Details.

e. Adjust the elevations of and reconstruct the slope drains so that the slope drains remain functional as the embankment elevation rises.

2. Maintenance

a. Maintain embankment slopes, edge berms, and interceptor berms in accordance with Section 202.

b. Inspect the drain system for clogging or breaks. Clean and repair.

3. Removal

a. Remove the temporary slope drain when the contributing drainage area is stabilized at a density of 70 percent as determined by the engineer. Stabilize areas disturbed by drain construction in accordance with Section 908 immediately after removal.

D. Compost Filter Log

1. Construction

a. Submit product technical data for preassembled logs for approval before use.

b. Assemble compost filter logs by tying a knot in 1 end of the filter sock, filling the sock with the composted materials, and knotting the other end when at the desired length. Fill the filter sock leaving no gaps in compost. Keep large materials that would impede flow or create gaps out of the sock.

c. Angle the compost filter log upslope to prevent runoff from washing around the ends. Ensure that the log ends are at least 1-foot higher than the middle. Place hardwood stakes 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 3-feet long. Set the stakes a minimum of 12-inches below grade.

2. Maintenance

a. Replace torn, damaged, or flattened logs throughout the life of the contract.

b. Remove accumulated sediment when the sediment reaches 50 percent of the height of the compost filter log.

3. Removal

a. Remove the compost filter log when the engineer determines it is no longer required.

b. Stabilize disturbed areas in accordance with Section 908.

907.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Stone check dam as the number of tons of riprap placed and accepted.

2. Temporary slope drain as the number of linear feet measured from end to end of pipe, installed and accepted.

3. Compost filter log as the number of linear feet completed and accepted.

907.5 Basis of Payment.

A. The Department will pay the quantity of water control practices at the contract unit price for each acceptably placed. Price and payment constitute full compensation for:

1. Providing all materials;

2. excavating, backfill, and backfilling;

3. installation;

4. temporary stabilization;

5. maintenance;

6. removal;
7. restoring the site; and
8. permanent stabilization.

B. The Department will pay the quantity of clearing and grubbing required for temporary swale construction in accordance with Section 201.

C. The Department will not pay for replacement of riprap during the project construction period.

D. The Department will consider sediment removal as incidental to the water control practice item.

E. The Department will pay for additional pieces of slope drain the contractor added to existing temporary slope drain in the same manner as payment for the existing temporary slope drain.

F. The Department will pay the quantity of edge berm according to Section 202.

ITEM	DESCRIPTION	UNIT
907001	TEMPORARY SLOPE DRAIN, 15”	LF
907011	STONE CHECK DAM	TONS
907017	COMPOST FILTER LOGS	LF

SECTION 908 — SOIL STABILIZATION PRACTICES

908.1 Description.

This work consists of soil stabilization practices using perennial grasses, topsoil, topsoiling, and mulching.

908.2 Materials.

A. Topsoil

1. Friable loam soil of uniform quality and free from heavy clay, frozen clods, lumps exceeding 2 inches in diameter and materials harmful to plant growth.
2. Void of Johnsongrass *(Sorghum halapense)*, Canada Thistle *(Cirsium arvense)*, Burcucumber *(Sicyos angulatus)*, Giant Ragweed *(Ambrosia trifida)*, and Texas Amaranth *(Amaranthus palmeri)*.
3. Determine and incorporate the type and amount of soil amendments, supplements, and process needed to establish permanent vegetation.

B. Topsoiling

1. This material consists of the existing project soils designated for stripping, salvaging, and temporarily stockpiling for later use in accordance with Section 202.
2. Void of Johnsongrass *(Sorghum halapense)*, Canada Thistle *(Cirsium arvense)*, Burcucumber *(Sicyos angulatus)*, Giant Ragweed *(Ambrosia trifida)*, and Texas Amaranth *(Amaranthus palmeri)*.
3. Determine and incorporate the type and amount of soil amendments, supplements, and process needed to establish permanent vegetation.

C. Seeding

1. Use water meeting the requirements of Section 1021.
2. Grass and Agricultural Seeds.
   a. Use seeds conforming to 3 Del. C. 1953, §1501.
      i. For blended seed in bags, display a seed tag attached to the bag.
      ii. For project mixed seed of special seed formulas or mixtures not specified in Tables 908.2-1 through 908.2-3 and Table 908.2-5, use seed previously inspected, tested, and approved by the Delaware Department of Agriculture for the designated purity, germination, weed seed limits, and pure live seed analysis.
      iii. Provide seed void of Johnsongrass *(Sorghum halepense)*, Canada Thistle *(Cirsium arvense)*, Burcucumber *(Sicyos angulatus)*, Giant Ragweed *(Ambrosia trifida)*, and Texas Amaranth *(Amaranthus palmeri)*.
   b. Use the following seeding tables:
      i. Table 908.2-1 - Permanent Grass Seeding - Dry Ground (PGS-DG)
      ii. Table 908.2-2 - Grass Seeding - Stormwater Facility (GS-SF)

iii. Table 908.2-3 - Permanent Grass Seeding - Subdivision Mix (PGS-SUB)

iv. Table 908.2-4 - Temporary Grass Seeding (TGS)

v. Table 908.2-5 - Permanent Grass Seeding - Streambank (PGS-SB)

Table 908.2-1 - Permanent Grass Seeding - Dry Ground (PGS-DG)

Species	%Weed[1]	% Purity	% Germination	Lbs./Ac.	Seeding Dates
Hard Fescue Mixture *(Festuca longifolia and Festuca trachyphylla)*	0.15	98	85	100	
Creeping Red Fescue *(Festuca rubra L)*	0.15	98	85	85	
Redtop *(Agrostis alba)*	0.75	95	90	40	
Trifolium repens L. var. "White Clover"[4]	0.10	75	80	5	
Total Perennial Seed Quantity[2] (lbs/Ac.)				230	
Winter Cereal Rye *(Secale cereale)*	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 italica)*	0.5	95	95	20	1 May – 31 July

Table 908.2-2 - Grass Seeding - Stormwater Facility (GS-SF)

Species	%Weed[1]	% Purity	% Germination	Lbs./ Ac.	Seeding Dates
Redtop (*Agrostis alba)*	0.15	95	90	30	
Indian Grass (*Sorghastrum nutans)*	1.00	85	75	20	
Deertongue (*Dichanthelium clandestinum)*	1.00	95	60	20	
Switchgrass (*Panicum virgatum)*	1.00	95	70	40	
Tickseed Sunflower (*Bidens aristosa)*	0.09	98	91	10	
Black-Eyed Susan (*Rudbeckia hirta)*	0.00	99	97	10	
Partridge Pea (*Chamaecrista fasciculata)*	0.22	99	93	10	
Yellow Blossom Sweetclover (*Melilotus officinales)*	0.10	99	92	10	
Total Perennial Seed Quantity[2] (lbs/Ac.)				150	
Winter Cereal Rye *(Secale cereale)*	0.75	98	85	50	1 Nov – 15 Feb
Annual Oats *(Avena sativa)*	0.15	95	90	40	16 Feb – 30 Apr

					1 Aug – 31 Oct
Foxtail Millet *(Setaria italica)*	0.5	95	95	40	1 May – 31 July

Table 908.2-3 - Permanent Grass Seeding - Subdivision Mix (PGS-SUB)

Species	%Weed[1]	% Purity	% Germination	Lbs./Ac.	Seeding Dates
Turf-type Tall Fescue Cultivar[3] *(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	
Trifolium repens L. var. "White Clover"[4]	0.10	75	85	5	
Annual Ryegrass *(Lolium multiflorum)*	0.15	95	90	20	
Total Seed Quantity (lbs/Ac.)				315	

Table 908.2-4 - Temporary Grass Seeding (TGS)

Species	%Weed[1]	% Purity	% Germination	Lbs./Ac.	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 908.2-5 - Permanent Grass Seeding - Streambank (PGS-SB)

Species	%Weed[1]	% Purity	% Germination	Lbs./Ac.	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. The Department will not allow these seeds in the allowable percentage of weed seeds.
2 Add the applicable quantity of seasonal nurse crop as listed according to the seeding date.
3 Base selection of Turf-type Tall Fescue Cultivars on performance within the Mid-Atlantic region as determined by the most current National Turfgrass Evaluation Program Progress Report.
4 Trifolium repens L. var. "White Clover" requires inoculation by Rhizobium leguminsarum biovar trifoli before seeding, unless purchased as pre-treated.

D. Erosion Control Blanket

1. Select from Rolled Erosion Control Products from the Approved Products List (https://deldot.gov/Business/index.shtml#). The Department will not accept photodegradable products.

E. Turf Reinforcement Mat

1. Select from Rolled Erosion Control Products from the Approved Products List (https://deldot.gov/Business/index.shtml#). The Department will not accept photodegradable products.

G. Erosion Control Mulch

1. Use hydraulic mulches when the manufacturer pre-packages all components. The Department will not accept field mixing of hydraulic mulch additives or hydraulic mulch components. The Department will not accept paper or paper blend mulches.
2. Provide straw mulch consisting of unrotted small grain straw free of weeds.

E. Stabilized Construction Entrance

1. Seed Section 908
2. Stone, Delaware No. 3 Section 1004
3. Geotextile Section 1060

908.3 Construction.

A. Handle temporary stockpiled materials as follows.

1. Store stockpiled material within the LOC and maintain a minimum of 50-feet away from streams, open channels, drainage inlets, and wetlands.
2. When stockpiling material outside of the LOC, do so in accordance with the contract and provide an approved Erosion & Sediment Control plan. Stabilize the work in the time specified in accordance with Section 908.3.B.
3. Install erosion and sediment control items in accordance with the contract and as directed by the engineer around the base of the pile in advance of the actual stockpiling operation in the time specified in accordance with Section 908.3.B. Place erodible earth material in neat piles. The engineer will decide the pile height requirement within the operational right of way. Do not exceed a height of 20-feet for piles not within the operational right of way. Seed and mulch all erodible temporary stockpile surfaces in accordance with the temporary or final stabilization requirements of this section.

B. Temporary and Final Stabilization

1. Temporary Stabilization consists of operations required for complete temporary stabilization as determined by the engineer.
2. Final Stabilization is complete vegetation growth consisting of perennial grasses reaching a height of 3-inches and 70 percent uniform density over all seeded areas.
3. Stabilize all erodible earth material exposed by the work within the time frames specified below:

Table 908.3-1 Stabilization of Erodible Earth and Maximum Allowable Time to Stabilize

Location	Type of Stabilization	Maximum Time to Stabilize
Sediment Controls	Temporary Stabilization	7 calendar days from completion of construction of BMP devices such as ditches, sediment traps, or dewatering basins.
Short term inactivity not meeting final grade and not to exceed 6 months	Temporary Stabilization	14 calendar days from the end of ground disturbing work in the location.
Areas meeting final grades or areas that will be inactive longer than 6 (6) months	Final Stabilization	7 calendar days from the end of ground disturbing work in the location.

C. Slope Tracking

Track a cleated piece of equipment, such as a bulldozer, up and down the slopes so the cleats make horizontal indentations in the soil. Upon request from the contractor, the engineer may approve a different tracking pattern.

D. Points of Ingress and Egress

Construct, maintain, and remove stabilized pads of aggregate on a geotextile base at every exit from the construction site to prevent tracking dirt off-site.

E. Topsoil Construction

1. In areas where topsoil stripping is to occur, clear all brush, sticks, weeds, stones, bricks, ashes, and other refuse that may hinder or prevent growth of future plant materials in areas that call for topsoil placement.
2. Do not place frozen topsoil or place topsoil on frozen grade. Remove clods and lumps larger than 2 inches in diameter.
3. Determine and incorporate the type and amount of soil amendments, supplements, and process needed to create the proper conditions for acceptance of permanent vegetation.
4. Loosen topsoil 3-inches deep within 72-hours before seeding.
5. Maintain topsoil until project acceptance.

F. Topsoiling

1. Place topsoil in accordance with Section 908.3.E.
2. Maintain topsoil in accordance with Section 908.3.E.

G. Seeding

1. The engineer will document the seed bag tags before seeding. Use seed mixes in accordance with Section 908.2.C.2 or as indicated in the contract.
2. Keep seeded areas free from weeds and debris in accordance with Section 105.13.

H. Erosion Control and Mulching Products

1. Submit product information and manufacturer's recommendations for product placement to the engineer no less than 2 working days before placement.
2. Place channel stabilization the same day of seeding operation. All other placement may occur within 1-week or before the next rain event.
3. Maintain all erosion control products in accordance with the contract and the manufactures recommendations.
4. Mulches
   a. Spray hydraulic mulches in accordance with the manufacturer's recommendations.
   b. Straw Mulch

      Spread straw mulch at a rate of 2-tons-per-acre. Immediately after placing the straw mulch, anchor mulch by crimping, tracking, liquid mulch binder, paper fiber, or netting. Apply liquid binder at the manufacturer's application rate. Use 100 percent biodegradable netting secured so that the straw mulch does not move. Do not use plastic netting.

   c. 100 percent soil coverage at the conclusion of the operation.
5. Erosion Control Blanket

   Place erosion control blankets in accordance with the manufacturer's recommendation.
6. Turf Reinforcement Mat

Place turf reinforcement mat in accordance with the manufacturer's recommendation.

I. Stabilized Construction Entrance

1. Construct stabilized construction entrances in accordance with the contract.
2. Obtain the engineer's approval before adding to, deleting from, or changing the stabilized construction entrance location.
3. When the contract requires pipe underneath the stabilized construction entrance, place the pipe and grade to drain. Place the pipe before placing geotextile or stone. Excavate to the dimensions shown in the Standard Construction Details. Compact the subgrade, place geotextile on the compacted subgrade, and place the stone on top of the geotextile to the required depth.
4. Stabilize the entire width of each ingress and egress location. The engineer may direct the Contractor to widen the entrance as required to prevent the entrance location from becoming a source of sediment.
5. Stabilized Construction Entrance Maintenance.
   a. Ensure that all paved surfaces adjoining the project limits are free of dirt at the end of each day.
   b. After heavy use and after each rain, inspect the stabilized construction entrance to ensure proper functioning. When the stone voids become filled with dirt, rake the surface to reestablish the voids.

J. Stabilized Construction Entrance, Top Dressing

Remove and replace the tope 2-inches of stone with 2-inches of clean Delaware No. 3 stone when voids are filled, or as directed by the engineer.

K. Removing Stabilized Construction Entrance.

When the stabilized construction entrance is no longer needed for project access, or when directed by the engineer, remove all stabilized construction entrance materials. Restore to grade and stabilize the restored areas.

908.4 Method of Measurement.

A. The Department will measure the quantity of soil stabilization work acceptably completed as follows:

1. Topsoil by the square yard or ton.
2. Topsoiling by the square yard or ton.
3. Mulching by the square yard.
4. Seeding by the square yard.
5. The Department will measure Erosion Control Blankets (ECB) and Turf Reinforcement Matting (TRM) by the square yard.
6. Stabilized construction entrance by the square yard.
7. Stone used for the topdressing by the ton.
8. Drainage pipe by the linear foot.

908.5 Basis of Payment.

A. The Department will make no payment for the installation of erosion and sediment controls or stabilization required by other agencies having jurisdiction on stockpiles located outside the areas designated in the contract.

B. The Department will pay the quantity of topsoil at the contract unit price per square yard or ton. Price and payment constitute full compensation for:

1. Preparing the grade;
2. providing, hauling, and placing all materials;
3. maintaining topsoil;
4. loosening the topsoil; and
5. soil amendments and supplements.

C. The Department will pay the quantity of topsoiling at the contract unit price per square yard or ton. Price and payment constitute full compensation for:

1. Preparing the grade;
2. hauling and placing all topsoil salvaged in accordance with Section 202;
3. maintaining topsoil;
4. loosening the topsoil; and
5. soil amendments and supplements.

D. The Department will pay the quantity and type of seeding at the contract unit price per square yard. Price constitutes full compensation for preparing the ground and for providing and placing all materials.

E. The Department will pay for the seeding in accordance with the payment schedule described in Table 908.5-1 as follows:

Table 908.5-1. 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	100%	0%	100%

F. The Department will pay the quantity of erosion control and mulching product at the contract unit price per square yard. Price and payment constitute full compensation for providing and placing all materials. Should the contractor elect to use multiple products from the approved product list,

the unit price will apply to all products listed under the corresponding item description on the DelDOT approved product list.

G. The Department will pay the quantity of stabilized construction entrance at the contract unit price per square yard. Price and payment constitute full compensation for:

1. Preparing, providing and placing all material except the stone and drainage pipe;
2. maintaining the stabilized construction entrance during the project, excluding placing additional stone for topdressing;
3. for removing the stabilized construction entrance and topdressing; and
4. for restoring the site.
5. The Department will pay the quantity of stone in accordance with Section 302.
6. The Department will pay the quantity of drainage pipe in accordance with Section 601.

H. The Department will pay the quantity of stabilized construction entrance topdressing at the contract unit price per ton of stone. Price and Payment constitutes full compensation for:

1. Remove and disposal of existing materials;
2. providing and placing all material; and
3. maintaining the topdressing of the stabilized construction entrance during the project construction period.

I. The Department will consider costs associated with slope tracking as incidental to Section 202 and slope tracking costs for preparing a seedbed as incidental to the topsoil Item.

J. The Department will consider soil amendments, supplements, and process as incidental to the seeding item when purchased pre-treated.

908.5.1 Maintenance Bond.

A. Provide a maintenance bond for the appropriate seeding Items upon substantial completion of the work. Provide a maintenance bond that meets the following requirements:

1. Equals 100 percent of the value of all permanent grass seeding Items paid to the contractor;
2. contains original ink signatures, not mechanical reproductions or facsimiles;
3. names the contractor as the principal;
4. with a term of 1 full year beyond the completion of permanent seeding work; and
5. written by a surety or insurance company in good standing and licensed by the Delaware Department of Insurance to write surety bonds in the State of Delaware.

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, STORMWATER	SY
908016	PERMANENT GRASS SEEDING, SUBDIVISION	SY
908017	TEMPORARY GRASS SEEDING	SY
908019	PERMANENT GRASS SEEDING, STREAMBANK	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	SY
908024	STABILIZED CONSTRUCTION ENTRANCE, TOP DRESSING	TON
908026	EROSION CONTROL MULCH	SY

SECTION 909 — WATERWAY CONSTRUCTION PRACTICES

909.1 Description.

This work consists of constructing, maintaining, and removing temporary waterway diversions to allow work in existing waterway channels.

909.2 Material.

A. Sandbag Dike and Diversion.

1. Borrow — Section 1001
2. Sheeting, 6-mil — Section 1022.6.B
3. Pipe Culvert — Section 1031
4. Pre-fabricated sandbag
   a. Jute, woven polyester, or polypropylene mesh resistant to ultra-violet radiation.
   b. Minimum sack size approximately 16-inches by 25-inches measured inside the seam when the sack is when empty.

B. Geotextile Lined Channel Diversion

1. Stone, Delaware No. 3 — Section 1004
2. Geotextile — Section 1060
3. Fasteners

   Steel pins, 3/16-inch diameter, minimum 18-inches long.
4. Washers

   Steel, 1 1/2-inch diameter.

C. Turbidity Curtain

1. Curtain
   a. Synthetic material coated with suitable elastomeric or polymeric compound having a high resistance to weathering, ultraviolet light, hydrocarbons, fresh and saltwater, and temperature extremes.
   b. Tensile strength greater than 200-pounds when measured lengthwise or crosswise.
   c. Seams vulcanized welded or sewn with to the full strength of the material.
2. Flotation Units
   a. Flexible, buoyant to support the required width of the turbidity barrier.
   b. Maintaining freeboard at least 3-inches above the water surface level.
   c. Contained in a flotation sleeve or collar attached to the turbidity curtain.
3. Load Lines
   a. Fabricate into the top and bottom of the turbidity curtain.

b. Top load line consisting of woven webbing or vinyl sheathed steel cable, with a minimum breaking strength of 10,000-pounds.

c. Bottom consisting of 5/16-inch minimum galvanized steel chain in bottom hem of the turbidity curtain.

d. With devices that develop the full breaking strength for connecting to load lines in adjacent sections.

4. Shoreline Stakes

Anchor the turbidity curtain in place.

5. Fasteners

a. 5/8-inch long brass or copper staples; or

b. 17-gage galvanized or aluminized steel tie wires

6. Anchors

a. Standard marine type boat anchors.

b. Danforth type anchors for sandy bottoms.

c. Kedge or mushroom type anchors for mud bottoms.

d. Alternate anchoring methods, heavy concrete, weights, or driven pilings.

7. Rope

a. Polypropylene, 5/8-inch diameter.

b. Breaking strength 800-pounds.

D. Stream Diversion.

1. Sandbags
2. Geotextile Section 1060
3. Steel sheet piles Section 1032
4. Stone Section 1004

E. Stilling Well.

1. Riprap, R-4 Section 1006
2. Geotextile Section 1060

909.3 Construction.

A. Inspect weekly and immediately after every rainfall to maintain and make repairs as needed.

B. General Excavation

1. Excavate in a continuous and uninterrupted operation.
2. Stockpile excavated material outside the 100-year floodplain and temporarily stabilize in accordance with Section 908.

C. Sandbag Dike or Diversion

1. Construction
   a. Construct sandbag dikes or diversions in accordance the Standard Construction Details. Begin at the upstream end of the channel and proceed downstream.
   b. Overlap sheeting by covering the downstream portion with the upstream portion. Overlap at least 24-inches.
   c. Construct a weir in the sandbag dike in accordance with the project plans.
2. Maintenance

   Repair or replace to maintain an acceptable work environment.
3. Removal
   a. Remove the dike or diversion upon completion of all work with the approval of the engineer.
   b. Regrade the area to match the contours shown in the contract or match the grades that existed before construction if the contract does not show contours.
   c. Stabilize all areas affected by the sandbag dike or diversion in accordance with Section 908.

D. Geotextile Lined Channel Diversion
1. Construction
   a. Replicate in size and shape the cross-section of the natural channel, unless otherwise specified.
   b. Excavate from downstream to upstream.
   c. Excavate under dry conditions, including the downstream and upstream connection to the natural channel.
   d. Use sandbags to contain the stream.
   e. Install geotextile as shown on the Standard Construction Details.
2. Maintenance
   a. Inspect at the beginning and end of each day to ensure proper function.
   b. Make repairs immediately.
3. Removal
   a. Redirect stream flow to its natural path and remove the geotextile lined channel.
   b. Remove all materials related to the geotextile lined channel and backfill the area in accordance with Section 207.3.D.
   c. Regrade the area to match the contours shown in the contract or match the grades that existed before constructing the channel diversion if the contract does not show contours.
   d. Stabilize areas affected by the construction of the geotextile lined channel diversion in accordance with Section 908.

E. Floating Turbidity Curtain
1. Construction

a. Submit the manufacturer's drawings and technical specifications to the engineer before installing the turbidity curtain and its accessories.

b. Assemble and install a turbidity curtain in accordance with the manufacturer's directions.

c. Install the turbidity curtain parallel to the flow of water along the riverbank. Do not install the turbidity curtain perpendicular to the direction of stream flow. Perform construction activities generating any sediment or turbidity within the turbidity curtain.

d. Begin installing 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. Attach curtain panel ends together using rope lashings. Tie the top lashing to the anchor line. Place the anchors so the turbidity curtain remains in the plan location and the current does not pull the flotation devices under the water. If directed by the engineer, supply and place additional anchorage.

g. Fasten the curtain to the side of the stakes facing the work area generating the sediment and turbidity.

2. Maintenance

a. Maintain the turbidity curtain throughout the project construction period so that no sediment caused by the project enters the waterway.

b. Repair or replace all turbidity curtains damaged before installation, during installation, or during the life of the contract, to the satisfaction of the engineer.

3. Removal

a. Do not remove the turbidity curtain until completing the work in accordance with the contract. Minimize impacts to adjacent waters and other areas when removing turbidity curtains and related components. Upon removal, the turbidity curtains and related components become the contractor's property.

F. Stream Diversion

1. Construction

a. Dewater in accordance with Section 906.

b. Implement the contract design within the limits shown in the contract without additional impacts to the stream or wetland depicted on the environmental compliance sheet.

c. For additional impacts, submit a preliminary layout of the impacts to the engineer. Obtain written permission before proceeding with final design.

d. Comply with all applicable hydrologic and hydraulic engineering standards in effect when preparing a proposed alternative stream diversion plan regarding system capacity and potential surface water impacts, upstream and downstream of the stream diversion.

e. Upon obtaining permission to proceed with the final design of a proposal for an alternate stream diversion, prepare and submit the alternate in accordance with Section 105.4. Submit 3 copies of the final design and provide the following:

i. Detail demonstrating the adequacy of the materials, methods, and equipment in providing stream diversion and erosion and sediment control;

ii. an itemized list of all materials and equipment;

iii. scaled drawings of the proposal overlaid on the environmental compliance sheet in the plans;

iv. supporting computations;

v. all necessary supporting paperwork required for the submission of the permit modification request to the appropriate permitting agency; and

vi. a table of any increased temporary impacts to wetlands and open waters.

f. Provide a signature and seal on the plans from a professional engineer in the State of Delaware.

g. The Department's Environmental Studies Office will make application for permit modifications through the appropriate permitting authorities.

h. The Department will not 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 and response from the engineer may take as long as 2-months. The Department will not grant additional contract time for delays resulting from failing to schedule enough time for permit modification review and final decision.

i. Obtain the engineer's approval for installing and testing the approved stream diversion system before disturbing the existing structure.

2. Maintenance

Maintain each component in accordance with the contract.

3. Removal

Remove each component in accordance with the contract.

G. Stilling Well

1. Construction

a. Install to the dimensions shown in the contract or a minimum of 5-feet by 5-feet. Temporarily stockpile all channel bed material from the excavated area. When overlapping the sheeting, the upstream portion will cover the downstream portion, and overlap at least 24-inches.

b. Line all surfaces of the stilling well with the geotextile before placing the riprap. Place the geotextile and riprap as indicated on the plans, Standard Construction Details, and Section 707.

2. Maintenance

Maintain to the original dimensions and function throughout project construction. Remove and dispose of all trash and debris that enters the stilling well and interferes with the well function.

3. Removal
   a. Remove upon completion of all work, with the approval of the engineer.
   b. Regrade the area to match the contours shown in the contract or match the grades that existed before constructing the stilling well if the plans do not show contours.
   c. Stabilize all areas affected by the construction of the stilling well in accordance with Section 908.

909.4 Method of Measurement.

A. The Department will consider sediment removal as incidental to maintenance of the work. The Department will measure the quantity of work acceptably completed for waterway construction as follows:

1. Sandbag dike or diversion by the number of cubic feet of sandbags placed and accepted with 1 sandbag equaling 1-cubic foot.
2. Geotextile lined channel diversion by the number of cubic yards excavated and accepted.
3. Floating turbidity curtain by the number of linear feet of turbidity curtain placed and accepted measured from edge to edge along the support cable.
4. Stilling well by the number of cubic yards excavated and accepted.
5. The Department will not measure stream diversion.

909.5 Basis of Payment.

A. The Department will pay the quantity of sandbag dikes and sandbag diversions at the contract unit price per cubic foot. Price and payment constitute full compensation for:

1. Providing and placing all materials;
2. constructing;
3. maintaining;
4. temporary stabilization;
5. removing and disposing;
6. restoring the area; and
7. permanent stabilization.

B. The Department will pay the quantity of geotextile lined channel diversion at the contract unit price per cubic yard. Price and payment constitute full compensation for:

1. Excavating;
2. providing and placing all material;
3. maintaining;
4. temporary stabilization;

5. removing;
6. restoring the site; and
7. permanent stabilization.

C. The Department will pay the quantity of floating turbidity curtain at the contract unit price per linear foot. Price and payment constitute full compensation for:

1. Assembling;
2. installing;
3. maintaining; and
4. removing the turbidity curtain.

D. The Department will pay the quantity of stream diversion at the contract lump sum price. Price and payment constitute full compensation for:

1. Providing and placing all materials:
2. excavation and installation;
3. maintenance;
4. removal;
5. restoration;
6. design and preparation of plan submittals;
7. supporting paperwork and copies; and
8. permit acquisition costs.
9. The Department will consider the cost associated with repairing or replacing the stream diversion as included in the lump sum bid price and will make no separate payment for this work.
10. The Department will pay the for damage resulting from an overtopping event, including cleaning and rebuilding of the stream diversion system, under the force account provisions of these specifications. The Department will not pay for any stream diversion materials placed before the engineer's approval.
11. The Department will consider materials used for the stream diversion system as the contractor's property after removal.
12. The Department will pay for dewatering the work area in accordance with Section 906.

E. The Department will pay the quantity of stilling well at the contract unit price per cubic yard. Price and payment constitute full compensation for:

1. Providing all materials;
2. excavating, backfill, and backfilling;
3. maintaining;
4. temporary stabilization;
5. removal;

6. restoring the site;
7. backfilling; and
8. permanent stabilization.

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

910.1 Description.

This work consists of constructing stormwater management facilities.

910.2 Materials.

A. Infiltration Stone (No. 3, No. 8, or No. 57) Section 1004
   1. Washed, free of stone dust, fines, or soil particles
   2. Maximum of 2 percent passing #200 sieve when tested in accordance with AASHTO T11.
   3. Do not use crushed concrete or recycled asphalt pavement (RAP)
   4. Geotextile Section 1060

B. Clay Borrow
   1. Borrow Sources Section 209.3.1
   2. Borrow Source Testing Section 209.3.2
   3. Cut-Off Trench, Clay Borrow, Type 2 Section 1002.1
   4. Pond Liner, Clay Borrow Type 1 Section 1002.1

C. Outlet Structure, Concrete
   1. Borrow Section 209 and Section 1001
   2. Concrete
      a. Riser structures - precast or cast in place.
      b. Cast-in-place concrete - walls, anti-seep collars, and principle spillway bedding.
      c. PCC, Class A Section 1022
         i. Foundations, riser structures, retaining and weir walls, principle spillway pipe bedding, and anti-seep collars.
   3. Reinforcing Steel, Grade 60 Section 1037
   4. Liquid Membrane-Forming Compounds for Curing Section 1045.7
   5. Non-Shrink Grout Section 1047.2
   6. Pipe, principal spillway Section 1031
   7. Steps AASHTO M199 and ASTM C478
   8. Trash Rack – Aluminum
   9. Riprap Section 1060
   10. Turf Reinforcement Matting Section 908

D. Stormwater Management Pond
   1. Liner or cut-off trench material Sections 910.2B, 209, 908, 1001

E. Infiltration Trench

1. Polyvinyl Chloride (PVC) schedule 40 pipe, 6" Section 1031.2.D
2. HDPE Pipe Section 1031.2.A, 1031.2.B
3. Reinforcing Bar, epoxy-coated, No. 4 AASHTO M31, Grade 60 and ASTM A775

F. Bioretention Area

1. Biosoil Mix - from a DNREC approved vendor.
2. Polyvinyl Chloride (PVC) schedule 40 pipe, 6" Section 1031.2.D
3. Perforated, Corrugated Polyethylene Pipe, 6" Section 1031.2.A, 1031.2.B
4. Reinforcing Bar, epoxy-coated, No. 4 AASHTO M31, Grade 60 and ASTM A775

G. Biosoil Mix

1. Triple Shredded Mulch - Hardwood, aged 6-months minimum

H. Bioswale

1. Soil Amendment Section 908

910.3 Construction.

A. Contact the stormwater engineer or the delegated representative a minimum of 2 working days before starting construction on stormwater management facilities.

B. Concrete Outlet Structure

1. Construct In accordance with Section 610 and the following:
   a. After excavating, level and fill voids and cavities and compact the structure foundation. Dewater in accordance with Sections 902 and 906.
   b. To construct concrete riser, cast the concrete in place or use pre-cast concrete elements. Use lifting lugs to lift and transport pre-cast concrete risers. Do not use the top slab to lift the riser structure. Fill space between pipes and the pre-cast riser walls with non-shrink grout. The largest allowable dimension for the opening in the riser of connection of the outfall pipe is the outfall pipe diameter plus 4-inches.
   c. 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.
   d. Construct flow channel in accordance with Section 602.3.B.12 when applicable.
   e. Construct principal spillway outfall pipe in accordance with Section 601 and the following:
      i. Use Class A concrete in accordance with Section 1022. Place as shown in the Standard Construction Details. Use concrete shims to establish grade and alignment of the pipe. Do not use lumber, masonry bricks, or any other non-concrete material for shims.
      ii. When placing the principal spillway outfall pipe partially or completely in fill, construct the fill embankment 24-inches above the proposed top of pipe. Excavate the trench once the fill is in place.

f. Maintain the outlet structure until project completion by removing accumulated sediment and trash, stabilizing eroded areas, maintaining watertight joints, and as determined by the engineer. Dispose of sediment in accordance with Section 106.8.

C. Stormwater Management Pond

1. Before constructing the dam foundation and reservoir, clear and grub the area of trees, logs, stumps, roots, brush, boulders, sod, topsoil, and rubbish. Grade all surfaces under the foundation to remove irregularities.
2. Construct the outlet structure in accordance with Section 910.3.B and as noted in the Contract.
3. Excavation
   a. For a wet or dry stormwater management pond, excavate to the lines and grades shown in the contract.
   b. Excavate for an infiltration basin to within 2-feet of the designed bottom elevation, while maintaining the slope required as shown on the plans. Do not allow construction equipment to travel within 2-feet of the designed bottom of an infiltration basin. Do not stockpile within the bottom footprint area of the infiltration basin. Install silt fence of compost filter logs between stockpiles and the top of bank.
   c. Obtain the concurrence of the stormwater engineer before removing the last 2-feet of material to the bottom of an infiltration basin. Remove the material by working from the middle of the facility to the outside edges or from 1 side to the other. Limit the amount of ingress and egress points to as few as possible. Upon removal of the last 2-feet of material, scarify the bottom elevation. Immediately stabilize ingress and egress points when no longer needed in accordance with Section 908.
4. Construct the foundation, embankment, and slope in accordance with Section 202, except for the infiltration basin bottom elevation. If the engineer allows, deposit the materials unsuitable for use in the dam foundation and embankment on slopes. Otherwise, use excess material meeting the requirements for embankment to construct embankments. Remove excess and unsuitable material. Excavate rock in accordance with Section 202.
   a. Key the foundation cut-off trench into original ground in accordance with the contract. Excavate the foundation cutoff trench to a minimum bottom width of 4-feet before placing the dam embankment. Construct side slopes for the cut-off trench no steeper than 1 to 1.
   b. Construct the pond liner in accordance with Section 202 and to the lines and grades shown in the contract.
5. Dewater in accordance with Sections 902 and 906.
6. Stabilize in accordance with Section 908, and in accordance with the Contract.
7. Maintain the stormwater management pond until final project acceptance. Maintenance includes:
   a. Annual mowing of side slopes;
   b. removing accumulated sediment and trash;
   c. stabilizing eroded areas in accordance with Section 908;

d. removing noxious or invasive plant species listed by the Delaware Department of Agriculture; and

e. disposing of sediment in accordance with Section 106.8.

D. Construct the infiltration trenches to the dimensions shown in the contract after concurrence from the stormwater engineer. Do not allow construction equipment to travel within 2-feet of the infiltration trench bottom area. Do not stockpile within 10-feet of the infiltration trench area. Install silt fence or compost filter log between stockpiles and the infiltration trench.

1. Subgrade establishment

a. Excavate to the design subgrade elevation. Do not allow construction equipment to run within 2-feet of the designed bottom elevation.

b. Prepare the foundation in accordance with the contract.

c. After completing the excavation, line the sides of the stone reservoir with geotextile. Place the geotextile with a 12-inch minimum overlap on the trench sides. Provide enough geotextile to completely cover the stone surface with a minimum of 2-feet overlap. Secure in place using excess infiltration stone or other methods approved by the engineer. Remove excess geotextile covering the stone surface after a satisfactory stand of permanent vegetation establishes itself, as determined by the engineer, and with concurrence of the stormwater engineer.

2. Aggregate placement

a. Construct an inspection port consisting of a 6-inch diameter schedule 40 PVC pipe with 4 rows of 3/8-inch diameter holes evenly spaced around the pipe and 6-inches on center vertically. Place a removable cap on the top and place an 18-inch length of rebar through the pipe from side to side and secure on the bottom to serve as an anchoring system. Extend the inspection port from the bottom of the trench to 1-foot above the top stone elevation.

b. Place No. 3 infiltration stone in accordance with the contract.

c. Place HDPE pipe in accordance with the contract, making sure to have solid non-perforated caps on both ends.

3. Maintain the infiltration trench until final project acceptance. Maintenance includes:

a. Annual mowing of side slopes;

b. removing accumulated sediment and trash;

c. stabilizing eroded areas in accordance with Section 908;

d. removing noxious or invasive plant species listed by the Delaware Department of Agriculture; and

e. disposing of sediment in accordance with Section 106.8.

E. Construct bioretention areas to the dimensions shown in the contract. Do not allow construction equipment to travel within 2-feet of the designed bottom of the bioretention area. Do not stockpile on or within 10-feet of the bioretention area. Install silt fence or compost filter log between stockpiles and the infiltration trench.

1. Construct outlet structures in accordance with Section 910.3.B and in accordance with the contract.

2. Excavate to the design subgrade elevation and scarify. Do not allow construction equipment to travel within 2-feet of the designed bottom elevation.
3. Prepare the foundation in accordance with the contract.
4. Bioretention Area Components Placement.
   a. Place the inspection port using 6-inch diameter schedule 40 PVC pipe with 4 rows of 3/8-inch diameter holes, evenly spaced around the pipe and 6-inches on center vertically. Wrap perforated pipe with a metal screen with openings no bigger than 1/2-inch and no smaller than 3/8-inch. Place a removable cap on the top and place an 18-inch length of rebar through the pipe from side to side and secure on the bottom to serve as an anchoring system. Extend the inspection port from the bottom of the trench to 1-foot above the top biosoil mix elevation.
   b. Place No. 8 infiltration stone in accordance with the contract.
   c. Place underdrain using 6-inch diameter schedule 40 PVC with 4 rows of 3/8-inch diameter holes, evenly spaced around the pipe and 6-inches on center vertically in accordance with the contract. Wrap perforated pipe with a metal screen with openings no bigger than 1/2-inch and no smaller than 3/8-inch. There are no perforations in the cleanout pipe.
   d. Place biosoil mix in accordance with the contract.
   e. Place a minimum of 4-inches of triple shredded mulch over the entire surface of the biosoil mix.
5. Dewater in accordance with Sections 902 and 906.
6. Stabilize in accordance with Section 908 and the contract
7. Maintain the bioretention area until final project acceptance. Maintenance includes:
   a. Annual mowing of side slopes.
   b. Removing accumulated sediment and trash.
   c. Stabilizing eroded areas in accordance with Section 908.
   d. Removing noxious or invasive plant species listed by the Delaware Department of Agriculture.
   e. Disposing of sediment in accordance with Section 106.8.

F. Construct bioswale to the dimensions shown on the contract after concurrence from the stormwater engineer. Do not allow construction equipment to travel within 2-feet of the channel bottom areas. Do not stockpile within 10-feet of the bioswale area.

1. Subgrade establishment
   a. Excavate to the design subgrade elevation. Do not allow construction equipment to run within 2-feet of the designed bottom elevation.
   b. Prepare the foundation in accordance with the contract.
   c. After completing the spreader excavation, line the sides of the stone reservoir with geotextile. Place the geotextile with a 12-inch minimum overlap on the trench sides. Provide enough geotextile to completely cover the stone surface with a minimum of 2-feet overlap. Secure in place using excess infiltration stone or other methods approved by the engineer. Remove excess geotextile covering the stone surface after a satisfactory stand of permanent

vegetation establishes itself, as determined by the engineer, and with concurrence of the Stormwater Engineer.

d. After completing swale excavation apply soil amendments and install plantings.

2. Stone Check Dam

a. Install stone check dam as shown on the plans and in accordance with Section 907.

3. Maintain the bioswale until final project acceptance. Maintenance includes:

a. Annual mowing of side slopes;

b. removing accumulated sediment and trash;

c. stabilizing eroded areas in accordance with Section 908;

d. removing noxious or invasive plant species listed by the Delaware Department of Agriculture;

e. disposing of sediment in accordance with Section 106.8.

G. Submit to the engineer all required post construction verification documentation required for BMP approval, in accordance with DNREC regulations. All stormwater BMPs must be approved by the Department prior to Final Acceptance.

910.4 Method of Measurement.

A. The Department will measure the quantity of:

1. Infiltration stone by the cubic yard of stone.
2. Clay borrow by the cubic yard measured in accordance with Section 209.4.
3. Concrete outlet structure by each or lump sum.
4. Stormwater management pond as the number of cubic yards of material used to construct the pond in accordance with Section 202.4.
5. Infiltration trench by the cubic yard.
6. Bioretention area by the cubic yard.
7. Biosoil mix by the cubic yard.
8. Bioswale by the cubic yard.

910.5 Basis of Payment.

A. The Department will pay the quantity of infiltration stone at the contract unit price per cubic yard. Price and payment will constitute full compensation for subgrade preparation and providing and placing all materials.

B. The Department will pay the quantity of clay borrow at the contract unit price per cubic yard. Price and payment will constitute full compensation for stripping, excavating, hauling, placing, and compacting borrow material.

C. The Department will pay the quantity of concrete outlet structures at the contract unit price per each or lump sum. Price and payment will constitute full compensation for excavating, dewatering, ground preparation, providing and placing all materials, placing and curing PCC, and welding.

D. The Department will pay the quantity of stormwater management ponds at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

1. Clearing and grubbing;
2. disposing of obstructions;
3. excavating;
4. placing embankment;
5. grading;
6. compacting;
7. removing and disposing of unsuitable material;
8. salvaging and stockpiling soil for re-use; and
9. dewatering.

E. The Department will pay the quantity of infiltration trench at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

1. Excavating;
2. foundation preparation; and
3. providing and placing all materials including geotextile fabric not paid for with infiltration stone.
4. The Department will pay for infiltration stone in accordance with Item 910001.

F. The Department will pay the quantity of bioretention area at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

1. Excavating;
2. foundation preparation;
3. providing and placing all materials; and
4. dewatering.
5. The Department will pay for:

a. Infiltration stone with Item 910002.

b. Biosoil mix with Item 910011.

G. The Department will pay for biosoil mix at the contract unit price per cubic yard. Price and payment will constitute full compensation for preparing the subgrade and providing and placing material.

H. The Department will pay for bioswale at the contract unit price per cubic yard. Price and payment will constitute full compensation for:

1. Excavating;

2. foundation preparation; and

3. providing and placing all materials.

4. The Department will pay for:

a. Stone check dam in accordance with Section 907.

b. Plantings in accordance with Section 911.

c. Infiltration stone in accordance with Item 910002.

d. Biosoil mix with Item 910011

I. The survey, preparation, and submission of as-built plans will be incidental to the BMP requiring post construction verification.

J. The Department will make no additional payment for maintenance of stormwater management ponds prior to final acceptance.

ITEM	DESCRIPTION	UNIT
910001	INFILTRATION STONE, NO.3	CY
910002	INFILTRATION STONE, NO.8	CY
910003	INFILTRATION STONE, NO.57	CY
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	CY
910010	BIORETENTION AREA	CY
910011	BIOSOIL MIX	CY
910012	BIOSWALE	CY

SECTION 911 — PLANTINGS

911.1 Description.

This work consists of providing and planting specified plants, shrubs, and trees and the replacement and cultural care of the material.

911.2 Materials.

911.2.1 Plant Material.

A. Quality

1. Provide plants nursery grown, true to type and nomenclature, and typical of their species or variety. The plants shall have a normal habit of growth with well-developed branch systems and vigorous root systems. Provide sound, healthy, and vigorous plants, free from defects, disfiguration, injury, disease of any kind, insect eggs, borers, and any infestation. The plants shall have been growing under similar climatic conditions to those of the locality of the project for at least 2 years before planting. Provide plant material grown in a soil similar to the area where the plants are designed to be installed. Do not provide plants grown in a muck type soil or other foreign type.
2. Inspect the plants before removal from the nursery to ensure that the plants meet these requirements. Provide freshly dug plants. The Department will not accept heeled-in or cold storage plants with the exception of plant material delivered before planting as outlined in Section 911.3.3.

B. Measurements

Provide plants conforming to all sizes and measurements specified in the plant list provided with the contract. The Department will not accept plants that do not have a normal balance between height and spread. When the contract does not contain any requirement or exact measurement, provide plants normal for the species and variety as listed in "American Standard for Nursery Stock" (ANSI Z60.1). Match plants as closely as possible where the contract requires symmetry. Measure plants for height and spread with the branches in the normal position. Measure the trunk diameter of all trees up to and including 4-inches in diameter sizes at a point 6-inches above the ground. Measure from 12-inches above the ground level for larger sizes. If the tree branches are not in accordance with the required height, prune the lower branches, without leaving unsightly scars and damaging the trunk to obtain the correct height. Do not prune branches for this effect before delivery to the site unless approved. The contractor may use plants larger in size than specified. For larger plants, provide with an earth ball or root spread proportionate to the increased size.

C. Inspection

Provide certificates of inspection of plant materials required by federal, state, or other authorities with the shipment of plants. Provide 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 project site. The engineer will inspect and approve plants before planting. The engineer may reject plants placed without prior inspection. Protect the plant materials according to best horticultural practices while in transit in to prevent drying or possible desiccation of plant tissue.

The engineer will not accept plant material arriving at the site with broken or loose balls, or dry or insufficiently developed roots, and weak or thin plants that are damaged or defective, or do not comply with the contract. The engineer reserves the right to reject all unsatisfactory stock. Remove plant material the engineer deems unsatisfactory.

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 the nursery trade. Size and grading shall conform to those listed in AAN's American Standards for Nursery Stock. No substitutions are allowed except by written permission of the engineer.

E. Availability

The engineer, after receiving a written request from the contractor for substitution, will review and verify the non-availability of the specified plant and size. The engineer will direct the contractor to provide certification in the form of 5 letters from 5 independent growers who list the specified plant form in their most current catalog, stating that the item in question is not available. Upon receipt of the letters substantiating that a substitution is justified, the engineer will approve the contractor's substitution request.

F. Experience

1. Special Condition No. 22 of the United States Corp of Engineers (USACOE) 404 permit states, "The mitigation and post-planting monitoring plans shall be developed and implemented by a firm with demonstrated expertise in wetland creation activities."
2. The firm that does the actual planting and seeding of the mitigation site shall provide a record of successful wetland woody and wetland herbaceous and seeding programs that have received final approval by the USACOE, 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 USACOE. Within 14-days of a request from the Department, forward information indicating compliance with the experience requirement.

911.2.2 Trees.

Provide 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 branched at 6-feet to 8-feet height unless otherwise directed.

911.2.3 Shrubs.

A. Provide shrubs, well branched, with full and compact growth and ample well branched root systems capable of sustaining vigorous plant growth.

B. For woody shrub cuttings, provide fresh 24-inch long stems of woody plants. Each cutting shall have a living terminal bud. Before installation, keep the cutting cool and moist to prevent desiccation. The engineer will not accept degraded, rotting, or dried out material.

911.2.4 Ground Cover and Herbaceous Perennials.

A. Provide ground cover within containers a minimum of 1-year old and grown within the specified container size for a minimum of 6-months unless otherwise approved or specified in the contract.

B. Provide herbaceous plant material within containers a minimum of 6-months old and that have grown within the specified container size for a minimum of 3-months unless otherwise approved or specified in the contract.

911.2.5 Soil Mix.

A. Planting topsoil in accordance with Section 908.

B. Peat moss and peat humus.

1. Provide peat moss from sphagnum peat bogs. Provide shredded peat moss, not dusty, and free of twigs, stones, hard lumps, roots, or any other undesirable materials. Moisten peat moss before use, but do not water 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 originates from sphagnum peat bogs.
2. Provide a natural peat humus 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. Provide humus free from sticks, stones, roots, and other objectionable materials. Samples taken at the source of supply shall have the following analysis:

Table 911.2-1. Soil Analysis Requirements

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. The contractor may use composted leaf mulch instead of peat moss or peat humus that is free of wood, metallic substances, glass, or other undesirable materials.

911.2.6 Fertilizer.

A. Provide fertilizer that is a 20-10-5 analysis or approved equal in accordance with the following minimum guaranteed analysis.

Table 911.2-2. Fertilizer Analysis Requirements

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 Derived from ferrous and potassium sulfates	1.60%
Iron Derived from ferrous sulfate	0.35%

B. Use formulated fertilizer in tablet form weighing a minimum of 20-grams each.

C. Use fertilizer that conforms to all state and federal regulations. Provide an affidavit or a product label from the vendor or a testing laboratory as to the available nutrients contained in the fertilizer.

D. Provide fertilizer in new, clean, sealed, and properly labeled packages or containers. The engineer may allow use of fertilizer failing to meet the specified analysis if the contractor applies sufficient materials to comply with the specified nutrients per unit of measure.

911.2.7 Mulch.

A. Provide mulch, shredded hardwood bark or wood chips, or an approved equal as accepted by the engineer. The engineer may visually inspect mulching materials before delivery at the planting site. Mulch shall conform to the following requirements:

B. Provide shredded hardwood bark from a deciduous hardwood source mechanically ground to a maximum size of 6-inches. Ensure that the bark is relatively free of bark fines dust and undesirable materials.

C. Provide wood chips stockpiled for at least 1-year before placement as verified by the Department's inspection representative. Do not provide wood chips that contain leaves, twigs, wood shavings, and sawdust, or other undesirable materials. Apply non-pelletized fertilizer, with analysis in accordance with Section 911.2.6.A, at the rate of 0.5-pounds per square yard before wood chip placement.

D. Select only one of the above mulches for use throughout the entire project. Submit written certification for the chosen mulch.

911.2.8 Stakes, Guys, and Related Materials.

A. Provide staking and guying in accordance with the Standard Construction Details or alternate method approved by the engineer.

B. Use hardwood tree stakes at least 2-inches by 2-inches rough sawed to the length required. Provide stakes free from knots, rot, or other defects that impair strength.

C. Use polymer or nylon guying straps 1 1/2-inches to 2-inches wide.

D. Follow manufacturer’s recommendations for installing ground anchoring systems.

911.2.9 Water.

A. Provide clean water free of oil, salts, acids, alkalis, sugars, organics, or other undesirable materials. Where water is drawn from a surface source, enclose the intake to exclude silt, mud, organics, trash, or other foreign materials.

B. Watering quantity is per 1,000-gallons of water applied and based on the following schedule:

1. Major trees- 15 gallons per tree;
2. minor trees- 10 gallons per tree;
3. shrubs- 5 gallons per shrub; and
4. perennials- 10 gallons per 100-square feet of planting bed.

C. Document the quantity of watering on the breakout sheet provided for this item.

911.3 Construction.

911.3.1 Planting Periods.

A. Plant balled and burlapped, potted, or container grown plant material from March 1 to May 16 and from September 1 to November 30.

B. Complete all planting of broadleaf evergreens, during the fall season, by November 1.

C. Treat all material planted from May 16 to August 31 with an approved anti-transpirant, as recommended by the manufacturer. The engineer will provide written approval for moving plants within this time period.

D. Install woody shrub cuttings as dormant materials between October 30 and December 1, or between March 1 and April 1.

E. The Department may allow extensions or reductions of the above-mentioned time periods depending on weather and soil conditions at the time and upon approval of the engineer after a written request. Planting outside the planting window does not relieve the contractor of the guarantee.

911.3.2 Soil Mixture.

A. All Plants Except Ericaceous Material

For each cubic yard of baled peat moss, or approved equal, add between 43 and 54 cubic yards, of planting topsoil for all plants except ericaceous material.

B. Ericaceous Plants

For each cubic yard of baled peat moss, or approved equal, add between 36 and 45 cubic yards, of planting topsoil for ericaceous plants. If providing peat humus instead 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. Mix other approved equal materials, in accordance with the manufacturer's recommendations, and upon written approval of the engineer.

C. Mix the above soil mixtures in an area approved by the engineer. Provide at least 48-hours advance notice to the engineer before preparing any soil mixture. For areas that will contain ground covers or herbaceous perennials, mix the soil in place, providing the existing topsoil is in accordance with Section 908.

D. Place fertilizer in accordance with Section 911.2.6 according to the following requirements:

1. For balled and burlapped, or container stock, position the plant in the hole, and backfill halfway up the root ball. Place the recommended number of fertilizer tablets evenly around the perimeter and adjacent to the root ball. Backfill, tamp, and water.
2. For small ground cover plants and herbaceous perennials, position the plant in the hole, and backfill halfway up the root medium. Place the recommended number of fertilizer tablets evenly around the perimeter and adjacent to the root medium. Backfill, tamp, and water.
3. For trees, use one, 20-gram tablet for each 1/2-inch of tree trunk diameter based on the size specified for planting.
4. For shrubs, use one, 20-gram tablet for each 12-inches of height or spread based on the size specified for planting.
5. For ground cover and herbaceous perennials, use one, 20-gram tablet for each plant.
6. Do not backfill any pits until the engineer or the engineer's inspector completes inspection of the excavation.
7. Remove excess excavated material from the project site.
8. Cover all backfill material with a waterproof material after mixing.

911.3.3 Digging and Handling.

Provide balled and burlapped plants with firm, natural balls of earth of ample proportions and diameters in accordance with in AAN's "USA Standards for Nursery Stock." The engineer will reject plants with root balls cracked, broken, or crushed before or during planting operations. Keep roots constantly moist. Protect all plants by covering with canvas, wet straw, burlap, moss, or other material. Keep covered until ready for planting. Do not plant trees with frozen earth balls. Provide plant materials grown in containers for at least 6 months. Ensure that there are no signs of root bound or insufficient ratio of planting medium versus root mass.

911.3.4 Plant Locations.

Place plants in accordance with the contract. Shift plant locations to avoid utilities, with the engineer's approval.

911.3.5 Planting.

A. Plant all trees and shrubs in pits in accordance with the contract. Do not excavate pits with vertical sides. Ensure that pits are deep enough that, when planted and settled, the root collar of the plant is at the same relation to finished grade as it was to the soil surface where the plant was grown. 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 as shown in the contract.

B. The Department will not allow plant pits to remain open overnight in residential areas, or in any location where the engineer determines an open pit will pose a potential hazard to pedestrians or traffic.

C. 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 so the crown of the plant is level with the finished grade after allowing for watering and soil settlement. 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 leaving the burlap under the balls. Dispose of 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. For the initial watering, completely saturate the backfill in the pits and beds on the same day as planting. Do not dump excavated material on grass without covering the grass with protection unless approved by the engineer.

D. Prepare ground cover and herbaceous perennial areas by rototilling to a minimum depth of 10 inches. Mix peat moss, peat humus, or approved equal separately to obtain the proportion of ground cover or herbaceous perennial soil mixture specified in the contract. The root system of the plant determines the actual depth for individual plant excavation beyond the minimum excavation stated above for soil mixing. 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.

E. Prune plants immediately after planting, or transplanting, to remove injured or dead wood. Ensure that trees inspected and tagged at the nursery conform to AAN Standards, do not alter the natural habit or shape of the plant with additional pruning after inspection and tagging. Prune with 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 on all bruises or scars on the bark, trace back and remove the injured cambium to living tissue. Smooth and shape all wounds to preserve the branch bark ridge.

F. Water plants, in accordance with Section 911.3.6, on the same day as planting.

G. Place a minimum of 4 inches of mulch on all areas of trees and shrubs. Place mulch the same day as planting.

H. Cut away and remove the wire baskets, nylon binding, and burlap from the top half of the root ball.

I. Place staking and guying specified on the same day as planting and mulching.

J. Throughout the course of planting, remove excess and waste materials from the site and keep seeded areas clean. When planting in a previously planted area, clear debris, rubbish, subsoil, and remove waste materials from the site immediately upon completion. Rake ground surfaces smooth. Repair grassed areas disturbed during construction.

911.3.6 Plant Establishment.

A. The plant establishment period for planting begins immediately after completion of all planting and replacements in accordance with Section 911.3.5. The plant establishment period consists of one full growing season. Ensure that the plants remain alive and healthy during the plant establishment period. A growing season is the period from May 1 through September 30. The Department will inspect planting completed by May 1 the same year during the first week of October, weather permitting. The Department will inspect any planting not completed by May 1 the following year during the first week of October, weather permitting. The engineer will direct the contractor to replace all dead or unhealthy plants identified within our inspection by December 1. The engineer’s approval of the replacements constitutes final acceptance.

B. Keep all planting areas free of weeds and grass during the life of the contract. The contractor may use a pre- or post-emergent herbicide to control grass and broadleaf weeds. The contractor will be liable for any non-target damage resulting from a misapplication. Remove all weeds and grass, including the root, that emerge within all plant beds and within the saucer limits of individual plants, beginning 10-days after the date of notification by the engineer. String trimmers are not considered to be an acceptable alternative for weed removal. Prune and apply insecticides or

fungicides as required, repair or replace stakes and guy straps and repair plant saucer washouts, as approved by the engineer.

C. Reset to grade plants that settle below or rise above the desired finished grades.

D. Remove any dead or unhealthy plants within 10-days of notification and replace during the next appropriate planting season.

E. Provide and plant replacement plants, with plants of the same kind, size, and quality in accordance with the contract.

F. Provide a warranty, in accordance with Section 911.4.1, for all plant material against defects including death and unsatisfactory growth. The Department will not require the warranty to cover defects resulting from incidents beyond the contractor's control, such as vehicular impacts or vandalism. Submit appropriate police reports, or other approved evidence verifying the cause of the damage, and the Department will take responsibility for replacement.

G. Water bi-weekly during the period June 15 through October 1. Continue watering, without interruption, until completing watering of all the plants on the project. Use water in accordance with Section 911.2.9. The Department will allow use of tree watering bags as a part of the watering operation. Remove the tree watering bags before primary inspection.

911.4 Method of Measurement.

The Department will not measure the quantity of planting.

911.4.1 Maintenance Bond.

A. Provide to the Department a maintenance bond upon substantial completion of the work on the form provided by the Department for Item 911000 - Plantings. Provide a maintenance bond that meets the following requirements:

1. Is written for a sum equal to 100 percent of the value of all planting items paid to the contractor, as detailed in the breakout sheet.
2. Contains original signatures, in ink, and not mechanical reproductions or facsimiles of any kind.
3. Names the contractor as the principle.
4. Written for a term of 1 full growing season, as defined in this specification, beyond the completion of permanent planting work.
5. Written by a surety or insurance company in good standing and licensed to write surety bonds in the State of Delaware by the Delaware Department of Insurance.

911.5 Basis of Payment.

A. The Department will pay the quantity of planting at the contract lump sum. Price and payment will constitute full compensation for:

1. Providing and placing all materials;
2. protecting plants after digging and before planting;
3. staking, excavating plant pits, pruning, and guying;
4. the care of the plants until completion and acceptance of all landscape work;

5. disposing of excess and waste materials;
6. replacement planting;
7. cleanup;
8. repairs to plant material, tree protection, straps, or staking;
9. repairs to damaged grassed, planted, or other landscaped area due to the project operations;
10. ensuring that topsoil meets the sieve analysis, acidity, and organic matter requirements;
11. applying sufficient materials to fertilizer that originally failed to meet the specified analysis;
12. using pre- or post-emergent herbicide to control grass and weeds; and
13. work outlined under Section 911.3.6.

B. The Department will pay the quantity of watering 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.

C. The breakout sheet attached to the proposal shows all plant material and the anticipated amount of water proposed for this contract. The lump sum price bid for 911000 – Plantings, is the sum of the total cost for all items listed.

D. The Department will adjust the lump sum payment in accordance with the contractor's unit prices for any additions or deletions.

E. The Department will process payment for the planting if the engineer accepts the work as satisfactorily completed. The Department will make no partial payment for any living plant unless the specified item is planted in accordance with these specifications. The Department will make no additional payment for using plants larger than specified.

F. On working day contracts, the Department will charge working days while the contractor is engaged in actual planting and directly related work such as plant pit excavation, staking, and mulching. The Department will not charge contract time during the plant establishment period described in Section 911.3.6.

G. The Department will consider the cost of removing and replacing plants that settle below or rise above the desired finished grades and replacing dead or unhealthy plants, described in Section 911.3.6, as incidental to this item and will make no separate payment for that work.

H. If providing plants smaller than specified, submit a credit to the Department for approval. Base the credit on the average wholesale value based on the difference between the specified size and the next smaller size. The average wholesale value needs substantiation with written submissions in accordance with Section 911.2.1.E.

ITEM	DESCRIPTION	UNIT
911000	PLANTINGS	LS

DIVISION 1000 — MATERIALS

1000.1 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 Manual, latest edition, unless otherwise specified in the contract.

Submit and track the proposed sources of all materials incorporated in the project. Material must conform as included and approved on the "source of supply." All source approvals are conditional based on the continued production of the respective materials meeting the requirements of the contract. Refer to Sections 106.1 and 106.2 for more detailed information.

SECTION 1001 — BORROW

1001.1 Material Requirements.

A. Use classification, characteristics, and definitions of terms for borrow according to requirements of:

1. AASHTO M57
2. AASHTO M145
3. AASHTO M146
4. AASHTO M147

B. Material must have:

1. Maximum dry density ≥ 90 pounds per cubic foot
2. Liquid limit ≤ 40
3. No frozen material, rubbish, boulders more than 6 inches, or organics

C. Types and requirements in addition to above:

Table 1001.1-1. 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

1002.1 Material Requirements.

Clay material must not contain rubbish, organic matter, or 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

1003.1 Material Requirements.

Fine Aggregate must not contain frozen material, rubbish, or organics.

Table 1003.1-1. Fine Aggregate Gradation Requirements

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)	1-10	0 – 25
No. 200 (75 µm)	0 – 4	0 – 5

SECTION 1004 — COARSE AGGREGATE

1004.1 Description.

A. 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.

1004.2 Material Requirements.

A. Submissions. The engineer will sample and test. Once a stockpile of material has been tested and approved, do not add additional material.

B. Material Properties. Uniform in quality and free of silt, clay, decomposed fragments, overburden material, soil, reinforcement, and other deleterious debris.

C. Gradation. Graded aggregate material conforming to the gradation requirements in Table 1004.2-1 or Table 1004.2-2 for the appropriate type:

Table 1004.2-1. Coarse Aggregate Gradation Requirements

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	0 – 70	0 – 25	0 – 5					0 – 10
10										100		85 – 100					10 – 30	
Rice										100		70 – 100		0 – 20		0 – 10		0 – 5
GABC, Type B						100		50 – 95				20 – 50		15 – 40			2 – 20	

Table 1004.2-2. Recycled Material Gradation Requirements

Material Type	Sieve Size (square openings), millimeters except where noted										
	2" (50)	1 ½" (37.5)	1" (25)	3/4" (19)	1/2" (12.5)	3/8" (9.5)	1/4" (6.3)	#4 (4.75)	#8 (2.36)	#100 (150 µm)	#200 (75 µm)
Bituminous Millings[1]		100		50-95				20-60		2-20	
RCA (Crushed Concrete)[1]		100		50-95				20-60		2-20	

[1] See Table 1004.2-3 for additional requirements for Bituminous Millings and RCA (Crushed Concrete)

Table 1004.2-3. Additional Requirements for Recycled Materials

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

SECTION 1005 — GRADED AGGREGATES

1005.1 Description.

Provide materials for GABC items as described herein.

1005.2 Requirements.

A. Submissions. The engineer will sample and test. Once a stockpile of material has been tested and approved, do not add additional material.

B. Material Properties. Uniform in quality and free of silt, clay, decomposed fragments, overburden material, soil, reinforcement, and other deleterious debris.

C. Gradation. Graded aggregate material conforming to the gradation requirements in Table 1004.2-1 or Table 1004.2-2 for the appropriate type:

D. The contractor may elect to use any of the following materials to meet the requirements of GABC, Type B:

1. Quarried Materials (GABC) per Section 1004 and
    a. Los Angeles Abrasion testing, per AASHTO T96, must show percent of wear less than or equal to 45 percent.
    b. Materials must be uniform in quality and composed solely of stone and stone dust.
2. RCA (Crushed Concrete) per Section 1004.
3. Bituminous millings per Section 1004.

Place all base course materials full depth. Do not mix sources or similar materials from different sources.

SECTION 1006 — STONE

1006.1 Stone for Riprap Material Requirements.

Use stone that is hard, durable, and free from structural defects. Stone must be free from foreign substances such as soil, shale, and organic materials. Stone 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).

Table 1006.1-1. Riprap Gradation (Percent Passing (Square Openings) by Weight)

National Stone, Sand, and Gravel Association (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	-----	15-50
4”	-----	-----	0-15	----
3”	-----	-----	-----	0-15

1006.2 Stone for Channel Bed Fill Material Requirements.

A. Use aggregate for channel bed fill that is natural, rounded, unwashed, and uncrushed meeting the gradation of Table 1006.2-1 when tested in accordance with AASHTO T-11 and T-27:

Table 1006.2-1. Channel Bed Fill Gradation (Percent Passing (Square Openings) by Weight)

Gradation Identification	Light	Medium	Heavy
5-inch	100	90-100 [1]	Gradation to be noted on Plan sheets
1-inch	70-100 [1]	0-20 [2]	
3/4-inch	30-95	-	
3/8-inch	0-10 [2]	-	

[1] Salvaged materials may contain material exceeding this size and be acceptable.

[2] Salvaged materials may contain up to 20% passing the 3/8-inch sieve but not to exceed 10% passing the #200 sieve when tested in accordance with AASHTO T-11.

B. Aggregate material may be located within the excavation area of the project. This material may be salvaged by separating and stockpiling the material.

C. Angular quarried aggregate is unacceptable.

D. Gradation applications:

1. Use light gradation in Sussex County.
2. Use medium gradation in Kent and New Castle Counties.

SECTION 1010 — RELEASE AGENTS

1010.1 Material Requirements.

Use asphalt release agents on truck beds, tools, and equipment to prevent asphalt and asphalt mix from adhering to surfaces. Material is to be formulated to not damage the asphalt mix by stripping asphalt from the aggregate. Material must be non-petroleum and non-hazardous and meet the requirements of Table 1010.1-1.

Table 1010.1-1. Asphalt Release Agent Requirements

Property	Test Method	Requirement
Flash point	ASTM D92 or D93	> 450 F
Stripping Test (Diluted)	AASHTO T383	≤ 0.08 %
Asphalt Pull-Off Test	AASHTO T383	≤ 65.0 %

SECTION 1011 — TACK COAT

1011.1 Description.

Provide material in accordance with 1011.2 for thin lift maintenance applications, typically less than 1 1/4-inches thick. Provide material selected from the approved product list and in accordance with manufacturer recommendations for all other applications.

1011.2 Asphalt Cement (PG Graded).

Provide PG-64-22 (PG 64S-22) as tack coat in lieu of emulsified asphalts.

1011.3 Emulsified Asphalts.

A. Anionic emulsified asphalt in accordance with M140 except the sieve test requirement for field samples collected at the point of use shall be a maximum of 0.4 percent.

B. Cationic emulsified asphalt in accordance with M208 except the sieve test requirement for field samples collected at the point of use shall be a maximum of 0.4 percent.

C. Polymer-modified cationic emulsified asphalts in accordance with M316 except the sieve test requirement for field samples collected at the point of use shall be a maximum of 0.4 percent.

D. Non-Tracking emulsified asphalt in conformance with Table 1011.3-1.

Table 1011.3-1. Non-Tracking Emulsified Asphalt Requirements.

Property	Test Method	Requirement
Saybolt Viscosity at 77 F, (SFS)	AASHTO T59	15-100
Storage Stability Test, 24 hours, (%)	AASHTO T59	1 maximum
Residue by Distillation or Residue by Evaportation, (%)	AASHTO T59	50 minimum
Sieve Test, No. 20, (%)	AASHTO T59	0.4 maximum for field samples
Penetration at 77 F, 100 g, 5 s, (dmm)	AASHTO T49	10-40
Solubility in Trichloroethylene, (%)	AASHTO T44	97.5 minimum

SECTION 1012 — ASPHALT CEMENT

1012.1 Material Requirements.

A. Asphalt Cement (PG Graded). Per AASHTO M320, Table 1 and tested per AASHTO R29 with the following exceptions:

1. Original DSR will be 1.00 to 2.20 kPa as tested by AASHTO T315
2. Use of recycled materials cannot raise the low temperature properties of the combined binder above 23 degrees C as tested by AASHTO T313.

B. Asphalt Cement (MSCR Graded). Per AASHTO M332 and tested per AASHTO R29 with the following supplemental information:

1. The standard test temperature is 64 degrees C for all grades except PG 58S-28 which is 58 degrees C.
2. Polymer modified asphalts for extreme grade, PG 64E-22, must meet the following equation when subject to a 3.2kPa shear stress in accordance to AASHTO R92:

$$R - (29.371 * J_{nr}^{-0.2633}) \geq 0.0$$

Where:

R = Average Percent Recovery
J_{nr} =Non-recoverable creep compliance

3. Use of recycled materials cannot raise the low temperature properties of the combined binder above -23 degrees C as tested by AASHTO T313.

SECTION 1013 — ANTI-STRIPPING ADDITIVES

1013.1 Material Requirements.

Use antistripping additives that are oil soluble, compatible with the asphalt cement, and promote strong adhesion characteristics with aggregates when added to asphalt cement. The additives will not change the binder grade of the asphalt cement. Additives must be heat stable for a minimum of 96 hours at the bituminous material's normal storage temperature.

SECTION 1014 — ASPHALT MATERIALS PRODUCTION

1014.1 Material Requirements.

Produce asphaltic base and surface material in accordance with:

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

1014.2 Fine Aggregate.

Table 1014.2-1. Fine Aggregate Requirements

Fine Aggregate Angularity (AASHTO T304) % Minimum		Sand Equivalency (AASHTO T176) % Minimum	Sodium Sulfate (AASHTO T104)	Deleterious Materials (AASHTO T112)
≤ 100 mm	> 100 mm		Maximum % Loss	
40	40	40	20	10

1014.3 Coarse Aggregate.

Table 1014.3-1. Coarse Aggregate Requirements

Coarse Aggregate Angularity (AASHTO T326) % 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 T112)
≤ 100 mm	> 100 mm		Maximum % Loss		
75/-	50/-	10	40	20	10

[1]XX/YY denotes that XX% of the coarse aggregate has 1 fractured face and YY% has 2 or more fractured faces.

1014.4 RAP / RAS.

The percent of recycled materials (RAP / RAS) allowed in the pavement mixture is calculated using the Materials and Research Recycled Mixture Program (RAP Calculator) available through the Materials and Research Section.

RAP used from stockpiles which have material continuously added must be blended from multiple sources. The Department will not permit incorporation of RAP materials from single source stockpiles.

Process the RAS materials so that 100 percent passes the 3/8” (9.5 mm) sieve. Use post-consumer or pre-consumer shingles free of foreign material, moisture, and asbestos fibers. Keep pre-consumer fiberglass-backed and organic felt-backed shingles separate and do not incorporate the 2 types of shingles into a single mix. The deleterious materials for RAS cannot exceed 1.5 percent of the total mass retained on the #4 (4.75mm) sieve.

1014.5 Warm Mix Additives.

Submit the following information at least 30 calendar days before production:

A. WMA technology and additive information, if applicable.

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 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 its tank, submit a separate quality control plan developed by the producer to the Department for review and approval at least 30 calendar days before production.

1014.6 Production Quality Control Plan Requirements.

Submit a quality control (QC) plan to the Materials and Research Section on an annual basis for each proposed production facility for review and approval before 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 Materials and Research section when requested. Maintain records of all inspections and tests for at least 1 year. Records must include the date, time, and nature of deficiency or deficiencies found; the quantities of material involved until correction of the deficiency; 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 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. The person responsible for quality control including inspection, sampling, and testing personnel.

2. The person who has the authority to take corrective actions on behalf of the contractor.

D. Testing laboratory – frequency of equipment calibrations used for testing.

E. Load number of QC samples.

F. Sampling technique.

G. Performance and frequency of tests:

1. Mixture temperature: first five trucks and each sampled load.
2. Aggregate, RAP, and RAS stockpile gradation analysis.
   a. Aggregate: 1 washed gradation test per week per stockpile;
   b. RAP/RAS: 5 gradation and asphalt cement content tests for dedicated stockpiles where new material is not being added; and
   c. RAP/RAS: 1 gradation and asphalt cement content test per week for stockpiles that continually receive material.
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 - quarterly per source.
7. Bulk specific gravity and absorption of blended material - quarterly per source.
8. Ignition oven calibration - 1 per year per mix JMF.
9. 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 1 working day as results become available. Plot the following:

1. Asphalt cement content.
2. Volumetrics (air voids, voids in mineral aggregates (VMA)).
3. Gradation values for the following sieves:
   a. #4 (4.75 mm)
   b. #8 (2.36 mm)
   c. #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 immediate corrective actions will cause 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 DOT testing procedures.

E. Using non-approved JMF proportions or materials.

F. Using the wrong binder grade of asphalt.

G. Failure to take corrective action per approved QC plan.

Steps taken for violations listed above in addition to rejection of the material in the case of failure to meet JMF requirements:

A. First offense: written notice of violation to the contractor.

B. Second offense: within 1 year from the date of the first offense, written notice of violation to the contractor.

C. Third offense: within 1 year from the date of the second offense, 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 offense will follow protocol established for the third offense.

1014.7 JMFs.

Develop and submit a job mix formula for approval of each mixture according to AASHTO R35 on Superpave mixture design software before starting production of a new mixture. Each mix design must 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 R35.

C. Plot of the percent asphalt binder by total weight of the mix (Pb) 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, and
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 4 trial asphalt binder contents determined according to AASHTO T209.

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 to determine the design requirements. JMF sieve percentage values conforming to the ranges shown in AASHTO R35.

I. Raw material of each JMF to establish ignition oven calibration correction numbers 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 according to AASHTO T283.

1014.8 JMF Design Parameters.

Use combined aggregates conforming to the gradation requirement specified in the following table when tested according to AASHTO T11 and AASHTO T27.

Table 1014.8-1. Nominal Maximum Aggregate Size Control Points, % Passing

Mix Name	BCBC (Bituminous Concrete Base Course)		B		C		C		C (Thin Lift)	
	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 mixture must have a minimum percent moisture sensitivity per AASHTO T283 of 80.

Satisfy the volumetric criteria of the target asphalt cement content in Table 1014.8-2 for the design aggregate structure:

Table 1014.8-2. Volumetric Property Requirements

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 1014.8-3. PCS Control Point for Mixture Nominal Maximum Aggregate Sizes (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 8,000 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.

1014.9 Approval of JMF.

Upon submittal of the JMF, the engineer will have up to 30 calendar days to review the submitted information.

1014.10 Production Facility Laboratory Requirements.

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 within the Asphalt Plant Lab Inspection Chelist in DelDOT's Materials Manual.

1014.11 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 non-holiday weekday before the release.

1014.12 Material Production Testing Equipment.

Maintain all the equipment used for handling, preparing, and testing materials in proper operating condition. Correct laboratory equipment malfunctions within 1 working day or production will be suspended. In the case of an equipment malfunction, the contractor must develop a solution, approved by the engineer, to fulfil testing requirements.
Document and maintain calibration records for the following referenced equipment in accordance with the manufacturer's guidelines:

A. Superpave gyratory compactor: once every year.
B. Ovens: once every 3 months.
C. Vacuum container and gauge (rice bowls): once every 3 months, verified once every month.
D. Balances and scales: once every year.
E. Thermometers: once every year; verified once every month.
F. Gyratory compactor molds and base plates: once every year.
G. Mechanical shakers: once every year.
H. Verify sieve conditions daily by visual inspection.

Document and file all calibrations. Provide records for review by the engineer at any time.

1014.13 Material Production Test Methods.

Perform material production tests in accordance with the following:

A. AASHTO T312 - Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor.
B. AASHTO T166, Method A (rapid method) - Standard Method of Test for Bulk Specific gravity (GMB) of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
C. AASHTO T308 - Standard Method of Test for Determining the Asphalt Binder Content of Asphalt Mixtures by the Ignition Method.
D. AASHTO T30 - Standard Method of Test for Mechanical Analysis of Extracted Aggregate.
E. AASHTO T209 - Standard Method of Test for Theoretical Maximum Specific gravity (G_{MM}) and Density of Asphalt Mixtures.

1014.14 Plant Production.

Operate plants per the manufacturer's recommendations.
Allow the engineer access to all parts of the mixing plant at all times 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 maintained in the preparation of the mixtures.

1014.15 Anti-stripping Additive Blending.

If required, blend anti-strip additive per the manufacturer's recommendations.

1014.16 Silo Storage Systems.

Convey the mixture from the plant to the storage system without a reduction in temperature, the segregation of the mix, or the oxidation of the asphalt.
Store mixture for a maximum of 12 hours.

SECTION 1015 — COLD PATCH

1015.1 Material Requirements.

A. Produce cold patch that is a uniform mixture of compatible mineral aggregate and bituminous material with uniformly coated aggregate and no stripping of the bituminous material from the aggregate. Incorporate 10 to 25 percent RAP in the mixture.The mix must be capable of storage in a stockpile for a minimum of 6 months without hardening or stripping and must remain workable in all weather conditions during the storage period.

B. Provide materials as specified in:

1. Coarse Aggregate	Section 1014.3
2. RAP / RAS	Section 1014.4
3. Bituminous Material	See Below

1015.2 Bituminous Material.

A. Must be a terminal blended material consisting of asphalt binder, a softening agent, and an antistrip agent.

B. Softening agents are not permitted to be hydrocarbon based and must be VOC free.

C. Bituminous material must be piped directly from the transporting tanker into the mixing plant.

D. Temperature of bituminous material must not exceed 170 degrees F, or the temperature recommended by the manufacturer in writing.

Table 1015.2-1. Bituminous Material Properties

Property	Test	Specification Limit
Flash Point (^{O}F min)	AASHTO T79	200
Kinematic Viscosity@ 140^{O}F cP (mm^{2}/s)	AASHTO T201	100-400
Percentage of Water (% max)	ASTM D95	0.2
Distillate Test (% Vol. of original sample)	ASTM D402	
To 437°F		0
To 500°F		0
To 600°F		0.1 maximum
Residue from Distillate at 680°F		90% minimum

Table 1015.2-2. Test on Residue from Distillate

Property	Test	Specification Limit
Penetration (dmm-min)	AASHTO T49	180
Solubility in trichloroethylene (% min)	AASHTO T44	99

Supply certificate of analysis, MSDS and verify free of volatile organic compounds (VOCs)

1015.3 Production Quality Control Plan Requirements.

Not applicable.

1015.4 JMFs.

A. Develop and submit job mix formula for the mixture 10 days before production.

B. JMF submission must include:

1. Proposed mixing facility
2. Proportions and Sources of:
   a. Aggregate
   b. Bituminous material
3. Gradation Master ranges

1015.5 JMF Design Parameters

A. Use combined aggregates conforming to the gradation requirements in the table below when tested according to AASHTO T11 and AASHTO T-27.

Table 1015.5-1. Aggregate Gradation Requirements

Sieve Size	% Passing
3/8" (9.5 mm)	90 - 100
No. 4 (4.75 mm)	20 - 85
No. 8 (2.36 mm)	5 - 40
No. 200 (0.075 mm)	0 - 7

B. Minimum 25% RAP

C. Based the effective asphalt binder content on the bituminous blend supplier's recommendation (allowable production tolerance of 0.4 percent) by weight of the total mixture.

1015.6 Mixing Requirements

A. Prepare aggregates per asphalt blend supplier requirements.

B. Continuously mix until all aggregates are thoroughly coated with bituminous material. Do not exceed the binder supplier's recommended mixing temperature.

C. Stockpile material in piles less than 5 feet in height for a minimum of 48 hours at the production facility to cool. The engineer will examine the stockpile for runoff and workability.

1015.7 Laboratory Testing.

A. The Materials and Research Section will obtain samples of the component materials and the produced mixture to test their qualities. Acceptance of the materials and the produced mixture will be based on field performance and the following tests:

Table 1015.7-1. Mixture Property Requirements

Property	Test Method	Specification Limit
Stripping	AASHTO T182	> 90% Coated
Draindown	AASHTO T305	< 8%
Workability/Storage Ability	ASTM D6704-08	< 3 @ 40^{o} F
Asphalt Content/Gradation	AASHTO T-308	See Job Mix Formula

B. The Department's initial approval of the material sources, mix design, plant facilities, or mixture based on aforementioned testing does not eliminate further examination and testing if unsatisfactory field performance occurs at the time of material use.

1015.8 Plant Production.

A. Operate plants per the manufacturer's recommendations.

B. Allow the engineer access to all parts of the mixing plant at all times 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 maintained in the preparation of the mixtures.

SECTION 1016 — EMULSIFIED ASPHALT

1016.1 Material Requirements.

A. Use emulsified asphalt that conforms to AASHTO M208 for unmodified and AASHTO M316 for polymer modified with a maximum temperature of 120 degrees F.

B. Specialty emulsions must meet contract requirements and the manufacturer's specifications.

1016.2 Sampling and Testing Requirements.

A. Sample all emulsions in the presence of the engineer. Place the sample in a clean plastic container provided by the engineer. Record the date of the sample, lot number, supplier and terminal, type of emulsion, supplier tank number, and gallons verified on the LB36 shown in the Materials Manual. Provide the samples to the engineer for testing in accordance with AASHTO T59.

1016.3 Acceptance Certification Requirements.

A. Supply the specific gravity and the certificate of analysis and compliance for each shipment.

SECTION 1020 — CEMENT AND POZZOLANIC MATERIALS

1020.1 Material Requirements.

A. Portland Cement. Type I, Type II, Type I/II, or Type III conforming to AASHTO M85-21.

B. Blended Hydraulic Cements. Type IP, Type IT, Type IS, or Type IL conforming to AASHTO M240-21 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 M295 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 M302.

E. Silica Fume. Per AASHTO M307.

1020.2 Production and Delivery.

A. 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 F.

B. The manufacturer can ship under certification after testing and approval of the QC plan by the Department. The Department reserves the right at any time to sample the product, modify the program, withdraw certification, require pretesting, and to use reserved bins or sealed shipments.

SECTION 1021 — WATER FOR PORTLAND CEMENT CONCRETE

1021.1 Material Requirements.

A. Mixing and curing water must be clean and free of oil, salts, acids, alkalis, sugars, organics, and other substances injurious to the finished product. Water known for potable quality may be used without testing. Water drawn from a surface source must be free of silt, mud, organics, trash, and foreign materials.

B. Water must meet ASTM C1602 and ASTM C1603 with the following modifications:

Table 1021.1-1. Modifications to ASTM C1602 and ASTM C1603

Property	Requirement
Hydrogen ion concentration	4.5 to 8.5 pH
Total solids	5,000 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)	2,000 ppm maximum
Compressive strength, minimum at 7 calendar days	90% of control specimen
Time of setting	+/-60 minutes from control and meeting AASHTO M85, Vicat test

SECTION 1022 — PORTLAND CEMENT CONCRETE PRODUCTION

1022.1 Material Requirements.

A. Produce PCC in accordance with the following:

1.	Portland Cement	Section 1020
2.	Blended Hydraulic Cement	Section 1020
3.	Fly Ash	Section 1020
4.	Ground Granulated Blast Furnace Slag	Section 1020
5.	Silica Fume	Section 1020
6.	Water	Section 1021
7.	Fine Aggregate	Section 1003 and below
8.	Coarse Aggregate	See below
9.	Fibers	See below
10.	Concrete Admixtures	See below
11.	Curing Membranes	See below

1022.2 Fine Aggregate.

A. Fineness modulus must be 2.3 to 3.1. Conform to AASHTO M6 except the grading should be per Section 1003.

1022.3 Coarse Aggregate.

A. Use coarse aggregate conforming to the requirements of AASHTO M80, except do not use RCA (Crushed Concrete). Use gravel that has a minimum of 1 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.

1022.4 Fibers.

A. Use fibers that is alkali resistant and conform to the requirements of ASTM C1116, Type III with a minimum fiber length of twice the length of the aggregate and a maximum length of 1 1/2-inch. The quantity of fibers used and their point of introduction into the mix is to conform to the fiber manufacturer's recommendations.

1022.5 Concrete Admixtures.

A. Air Entrainment Agents must conform to the requirements of AASHTO M154.

B. Chemical Admixtures must conform to the requirements of AASHTO M194.

C. Use only lithium admixtures certified as nonhardous based on heavy metal content.

D. Use only non-chloride admixtures.

1022.6 Curing Materials.

A. Liquid membrane-forming compound in accordance with Section 1045.7.

B. Sheeting – White opaque polyethylene film must conform to the requirements of ASTM C171 and have a minimum nominal thickness of 4 -mil.

C. Burlap – Plain woven cloth made of jute or kenaf, weighing 10 -ounces per square yard or greater that conforms to AASHTO M182 Class 3 or Class 4.

D. Water – Conform to Section 1021.

1022.7 Production Quality Control Plan Requirements.

1022.8 Concrete Mix Designs.

A. Design PCC to meet the requirements shown in this section based on its intended use.

B. Develop and submit a mix design for each class of concrete for approval at least 30-calendar 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 the concrete for the project.

C. Use a water reducing admixture in all classes of concrete. Determine the quantity and type or combination of admixtures based on the manufacturer's recommendations, the ambient and concrete batch temperatures at the time of placement, the geometry of the work, the concrete mix proportions, and other project specific parameters.

D. Include Supplementary Cementitious Materials as required in accordance with Section 1022.8.2. All concrete mixes will require Supplementary Cementitious Materials. A minimum of 15 percent fly ash or 20 percent slag is required.

E. Submit admixture technical data sheets for all incorporated admixtures with each mix design submission. The submitted technical data sheet must contain the percent solids, specific gravity, and pH at a minimum.

1022.8.1 Mix Design Methods.

Table 1022.8-1 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

A. 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.

B. Conduct trial batch testing of the proposed mix and submit the test results showing the specified minimum strength, air content, aggregate gradation, workability requirements, permeability, ASR

expansion limits, and additional self-consolidating concrete properties when necessary. In lieu of trial batches, break histories in accordance with ACI 318M may be submitted to the Department for consideration. The minimum sample population is 10 batches. The criteria established in ACI 214 will form the basis for approval of the proposed mix designs 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).

C. The mix design submission must include:

1. The proposed source of the materials,
2. the proportions of the mix components,
3. the laboratory test data from the trial batches or the break history,
4. the sample of the materials used, and
5. the test results of the proposed aggregates for ASR reactivity from a certified lab.
   a. When aggregates are ASR reactive, provide test results for the proposed concrete mixture components and mitigation steps in accordance with Section 1022.8.2.

1022.8.2 Alkali Aggregate Reactivity and ASR Mitigation.

1022.8.2.1 Reactivity Evaluation.

A. Evaluate the coarse and fine aggregates for use in the PCC for AAR using Table 1022.8-2 and any field service records available for the proposed materials. When field service records show evidence of AAR occurring in that source, the source is classified as reactive regardless of laboratory testing.

B. Test Aggregates using AASHTO T303 (AMBT) with a modification of the w/c ratio to 0.47 and a time limit for the test equal to 28 calendar days. The results of the AMBT will determine the reactivity in Table 1022.8-2 pending completion of ASTM C1293 (CPT). Once completed, the CPT test results will take precedence over the AMBT results for determining the reactivity class. Test data is valid for 3 years from date of material sampling. ASTM C1293 test results performed by AASHTO accredited laboratory may be accepted at the engineer's discretion.

C. Preventive measures are to be prescribed for the most reactive material included within a mix design.

D. Determine Aggregate Reactivity Class for alkali-silica reactivity and follow requirements prescribed in Table 1022.8-2.

E. Aggregates classified as alkali-carbonate reactive are not permitted for use in concrete production.

Table 1022.8-2. Classification of Aggregate Reactivity

Aggregate Reactivity Class	Aggregate Reactivity Description	28-Day Expansion in AMBT, %	1-Year Expansion in CPT (%)	Requirement
R0	Non-Reactive	≤0.10	≤0.04	Include Supplementary Cementitious Materials

				in accordance with 1022.8.D
R1	Moderately Reactive	>0.10 and ≤0.30	>0.04 and ≤0.12	Utilize ASR Preventative Measures in accordance with 1022.8.2.2 and test for efficacy in accordance with Section 1022.8.2.3 if the aggregate is to be used in concrete production
R2	Highly Reactive	> 0.30 and ≤ 0.45	> 0.12 and ≤ 0.24	Not Permitted
R3	Very Highly Reactive	> 0.45	> 0.24	Not Permitted

1022.8.2.2 ASR Preventative Measures.

A. Aggregates considered moderately reactive in accordance with Table 1022.1 may be incorporated for use in concrete production by meeting the applicable ASR preventive measures requirements in either Section 1022.8.2.2.A or Section 1022.8.2.2.B.

1022.8.2.2.A Limiting the Alkali Content of the Concrete.

A. Limit the alkali content of the concrete to a maximum of 2.5 pound per cubic yard. The alkali content of the concrete is calculated based on the alkali contributed by the Portland cement alone. For blended cement, the alkali available from the Portland cement component of the blend should be used. Refer to AASHTO R80 for additional information on calculating the alkali content of the concrete.

1022.8.2.2.B Using Supplementary Cementitious Materials or Blended Cements.

A. The amount of supplementary cementitious material required varies based on alkali content of the Portland cement used in the mix design. The required supplementary cementitious material may be added directly to the concrete mixer or it may be a component of a blended cement.

B. When two or more supplementary cementitious materials are used together to control ASR, the minimum replacement levels provided within this subsection for the individual supplementary cementitious material may be reduced provided the sum of the parts of each supplementary cementitious material is greater than or equal to 1.

1022.8.2.2.B.1 Portland cement with Alkali content of ≤ 0.40 percent Na_2Oe.

Include supplementary cementitious material in accordance with Table 1022.8-3.

Table 1022.8-3. Minimum Level of Supplementary Cementitious Material for Portland cement with Alkali content of ≤ 0.40 percent Na_2Oe

Type of SCM	Alkali Level of SCM, (% Na_2Oe)	Minimum Replacement Level (% by Mass of Cementitious Material)
Fly Ash	≤3.0	20
Fly Ash (CaO ≤ 18%)	>3.0, ≤4.5	25
Slag	≤1.0	35
Silica fume SiO_2 ≥ 85%	≤1.0	1.5 x LBA

1022.8.2.2.B.2 Portland cement with Alkali content of > 0.40 and ≤ 1.00 percent Na_2Oe.

Include supplementary cementitious material in accordance with Table 1022.8-4.

Table 1022.8-4. Minimum Level of Supplementary Cementitious Material for Portland cement with Alkali content of > 0.40 and ≤ 1.00 percent Na_2Oe

Type of SCM	Alkali Level of SCM, (% Na_2Oe)	Minimum Replacement Level (% by Mass of Cementitious Material)
Fly Ash	≤3.0	25
Fly Ash (CaO ≤ 18%)	>3.0, ≤4.5	30
Slag	≤1.0	50
Silica fume SiO_2 ≥ 85%	≤1.0	1.8 x LBA

1022.8.2.2.B.3 Portland cement with Alkali content of > 1.00 and ≤ 1.25 percent Na_2Oe.

A. Acceptable ASR preventive measures can either be achieved by limiting the maximum concrete alkali content to 2.5 pound-per-cubic yard and meeting the supplementary cementitious material requirements included in Table 1022.8-4 or by including supplementary cementitious material in accordance with Table 1022.8-5.

Table 1022.8-5. Minimum Level of Supplementary Cementitious Material for Portland cement with Alkali content of > 1.00 and ≤ 1.25 percent Na_2Oe

Type of SCM	Alkali Level of SCM, (% Na_2Oe)	Minimum Replacement Level (% by Mass of Cementitious Material)
Fly Ash	≤3.0	35
Fly Ash (CaO ≤ 18%)	>3.0, ≤4.5	40
Slag	≤1.0	65
Silica fume SiO_2 ≥ 85%	≤1.0	2.4 x LBA

1022.8.2.1.B.4 Portland cement with Alkali content of > 1.25.

Not permitted for use.

1022.8.2.3 Efficacy Testing.

A. Conduct efficacy testing in accordance with Table 1022.8-6. All testing must be performed by an accredited laboratory. Test data is valid for 3 years from date of material sampling. The Department will perform verification testing before accepting results at its sole discretion.

Table 1022.8-6. Tests and Criteria for Proposed Concrete Components

Procedure	Description	Limit
ASTM C1567 (modified[1])	Mortar Bar Expansion	< 0.08% at 28 calendar days

[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

662-10 “Determining the potential Alkali-Silica Reactivity of Combination of Cementitious materials, Lithium Nitrate Admixture and Aggregate.”

1022.9 Mix Design Properties.

Table 1022.9-1 Concrete Classes

Class of Concrete	Maximum w/cm ratio lb/lb	Air Content (Percent) (See Section 1022.13)	Minimum 28-day Compressive Strength f'_c (psi) (See Section 1022.13)	Maximum Permeability (Coulombs) (See Section 1022.13)	Fiber Requirements	Shrinkage Reducing / Compensating Admixture
A	0.40	4.0 – 7.0	4,500	2,000	Required when used in approach slabs	Required in barriers
B	0.45	4.0 – 7.0	3,000	3,000	N/A	N/A
B/SF	0.43	4.0 – 7.0	3,500	2,500	N/A	N/A
C	0.50	4.0 – 7.0	2,000	3,500	N/A	N/A
D	0.40	4.0 – 7.0	4,500	2,000	Required	Required
Rapid-set	0.40	3.0 - 7.0	4,500[1]	2,000	Required	N/A

[1]Obtain a minimum compressive strength of 2,000 PSI in 6-hours as measured by Sure-Cure mold test cylinders or the Maturity Meter in accordance with AASHTO T325. The Contractor is to provide Sure-Cure mold test cylinders and all associated equipment. The Department will provide the Maturity Meter.

Table 1022.9-2. Concrete Nominal Slump by Work Type[1]

Type of Work	Nominal Slump (inches)
Formed Elements:	
All Rapid-set Class Concrete [2]	2 to 5
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
Self-consolidating concrete	Refer to Section 1022.16

[1] Use only Type F or Type G admixtures for slumps greater than 4-inches. The maximum allowable slump is 8-inches.

[2] Slump may be increased up to 8-inches if Type F admixture is used.

1022.10 Material Production Requirements.

A. Notify the Department's Materials and Research Section of the quantity and time of scheduled release by 3:00 PM the non-holiday weekday before production.

1022.11 Handling and Storage of Materials.

A. Aggregates.

1. Stockpile aggregates on hard, clean, surfaces with positive drainage. The surface must be constructed of PCC or bituminous concrete that is of sufficient thickness to support the weight of the stockpile without rupturing or cracking. If the stockpile surface deteriorates and possibly contaminates aggregate stockpiles, immediately suspend concrete production until the surface is repaired. Maintain suitable partitions to separate and contain fine and coarse aggregate stockpiles. Stockpile coarse aggregate in a manner to avoid segregation.
2. Stockpile fine aggregates at the batch plant for a minimum of 24-hours or until surplus water has drained and the material has a uniform free moisture content before batching. Do not batch concrete using material directly from the washing plant. Maintain suitable partitions to prevent wet fine aggregates from mixing with fine aggregate.
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, immediately suspend operations until these conditions are corrected.

B. Cementitious materials.

1. Store cementitious materials in suitable structures that protect the material from hydration.
2. Do not use any cementitious material that shows signs of hydration such as lumps or cakes.

C. Admixtures.

1. Store admixtures to prevent contamination, stratifications, or deterioration.
2. Agitate admixtures according to the supplier's recommendation.
3. When admixture dosage rates differ from the manufacturer's recommendations, stop production of PCC until the problem is identified and corrected.

1022.12 Production Equipment Requirements.

Meet the requirements of AASHTO M157, except as modified herein:

A. Batch plants.

1. Material Measurement for batching.

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. Measure water, by weight or volume, to within ± 1 percent of the required batch quantity of water.

d. Weigh cement to within +1 percent of the target batch weight.

e. Maintain the admixture dispenser accuracy to within ± 1 percent of target volume.

2. Provide a computer printed ticket for each batch issued by the plant to the truck driver. The ticket must contain:

a. The name and location of the plant.

b. The approved mix designation.

c. The size and proportions of the batch.

d. The type and dosage rate of admixtures used.

e. The batch time (determined by the time water is introduced to the mixture).

f. The gallons of water withheld from the mixture that meets the maximum allowable water/cement ratio for the approved mix design.

3. Weighing scales:

a. Scales for weighing material must have a rugged design constructed to support the hopper or belts with minimum adjustments and be 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 1 set of the following calibration weights for verifying scale calibrations:

i. 10 standard 50-pound blocks,

ii. 11 standard 20-kg blocks, 1 standard 5-kg block, and 2 standard 1-kg blocks,

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. The engineer may perform an inspection of these weights.

4. Trucks for batch mix plants:

f. Mix each batch at a rate of rotation specified by the manufacturer more than 70 but less than 100 revolutions.

g. Inspect mixer drums for wear. The Materials and Research Section will verify the condition annually.

h. Keep interior drum surfaces clean of accumulations of hardened concrete material.

i. Replace drum blades when wear exceeds 1-inch of the original height.

j. Do not exceed the manufacturer's rating for the size of the batch that may be transported in these units when used as an agitator.

B. Central mix plants.

1. Central mix plants must have the capability of weighing and mixing all materials for PCC 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. Measure water, by weight or volume, to within ± 1 percent of the required quantity of water.
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 is 60-seconds.
8. The engineer will determine the minimum mixing time for batches greater than 10 cubic yards.
9. Mixing time begins when all material, except for mix water, has been added to the mixing drum.

C. Volumetric truck mixers.

1. Volumetric truck mixers must be calibrated annually by the Materials and Research Section prior to use.
2. Equip each truck with a 1/4 cubic yard box constructed of suitable rigid materials for calibration purposes.
3. Provide approved trucks capable of mixing batched materials sufficiently to dispense a uniformly homogenous mix at the point of placement with no further mixing required.
4. 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.
5. Dispense water through a calibrated meter displaying the discharge rate into the mixing auger.
6. The following tolerances for proportioning the various ingredients are as follows:
   a. Cement: -0 percent to +4 percent of target weight.
   b. Fine aggregate: ±2 percent of target weight.
   c. Coarse aggregate: ±2 percent of target weight.
   d. Admixtures: ±3 percent of target weight or volume.
   e. Water: ±3 percent of target weight or volume.

1022.13 Material Production Test Methods.

Mix properties will be verified by:

A. Mix consistency (slump): AASHTO T119

B. Temperature of fresh concrete: AASHTO T309

C. Air content: AASHTO T152 modified or AASHTO T196

D. Permeability: AASHTO T277, cured in accordance with the Accelerated Moist Curing Method.

E. Making and curing concrete test specimens: AASHTO T23

F. Unit weight: AASHTO T121

G. Compressive strength of concrete: AASHTO T22

1022.14 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 F.

C. The maximum allowable temperature for Rapid-set concrete is 95-degrees F.

D. The maximum allowable temperature for all other classes of concrete is 90 degrees F.

E. The minimum allowable temperature for Rapid-set concrete is 70-degrees F.

F. The minimum allowable temperature for all other classes of concrete is 50 degrees F.

G. Take appropriate actions in accordance with ACI 318 recommendations for hot weather concrete when batch temperatures at the mixing plant reach 6 degrees F below the maximum allowed for the class of concrete produced.

H. Take appropriate actions in accordance with ACI 306 recommendations for cold weather concrete when batch temperatures at the mixing plant reach 6 degrees F above the minimum allowable for the class of concrete produced.

1022.15 Delivery Time of Concrete Batches.

A. The maximum allowable elapsed time between the introduction of the mix water and the final placement of the concrete is 45-minutes for non-agitating transport vehicles and 60-minutes for agitating transport vehicles.

B. Delivery time restrictions may be extended with the use of approved water reducing/retarding admixtures, set retarding admixtures, and/or replacement of a portion of the Portland cement content with fly ash cement or GGBFDS cement.

C. 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 using mechanical concrete vibrators.

1022.16 Additional Self-Consolidating Concrete Requirements.

A. The Department will allow use of self-consolidating concrete on precast and prestress applications with approval of the engineer.

B. Self-consolidating concrete is to conform to all requirements within Section 1022 for the class of concrete specified in addition to the requirements listed in Table 1022.16-1.

Table 1022.16-1 Self-Consolidating Concrete Requirements

Property	Test Method	Requirement
Slump flow	ASTM C1611	20 to 30 but within +/- 3 inches of target slump

Visual stability index (VSI)	ASTM C1611	≤ 1
J-Ring	ASTM C1621	+/- 2 inches design slump flow
Static segregation	ASTM C1712	≤ 15 mm
Column segregation	ASTM C1610	≤ 15.0%

SECTION 1023 — PORTLAND CEMENT CONCRETE PATCHING MATERIAL

1023.1 Pre-Blended Concrete Mix.

1023.1.1 Material.

A. Coarse aggregate – Delaware no. 8 stone conforming to Section 1004 – Coarse Aggregate.

B. Water – Conform to Section 1021 – Water for Portland Cement Concrete.

1023.1.2 Mixing Requirements.

A. Use an on-site mechanical mixer to mix pre-blended patch mixes in accordance with manufacturer's proportions and recommendations.

1023.1.2 Pre-Blended Rapid-Set Concrete.

1023.1.2.1 Materials.

A. Consists of a blend of selected Portland cements, specially graded aggregates, admixtures for controlling setting time, water reducers for workability, and an accelerator.

B. Remains in a factory-blended bag or container that is accompanied with the manufacturer's recommendations.

1023.1.2.2 Mixing Requirements.

A. Use an on-site mechanical mixer to mix pre-blended patch mixes in accordance with manufacturer's proportions and recommendations.

SECTION 1024 – CONCRETE ADHESIVES

ASTM C881 is considered equivalent to AASHTO M235.

1024.1 Concrete Crack Repair Through Epoxy Injection:

A. Injection system cap sealing and port anchoring material. ASTM C881, Type IV, Grade 3. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

B. Structural concrete crack repair material. ASTM C881, Type IV. Meet grade requirements in Table 1024.1-1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

C. Non-Structural concrete crack repair material. ASTM C881, Type I or Type IV. Meet grade requirements in Table 1024.1-1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

Table 1024.1-1: Grade Requirements for Concrete Crack Repair Material

Crack Width	Grade
0.002 inch < Crack Width ≤ 0.01 inch	Grade 1
0.01 < Crack Width ≤ 0.25 inch	Grade 1 or Grade 2

1024.2 Non-Structural Concrete Crack Repair Through Gravity Feed:

A. ASTM C881, Type I or Type IV, Grade 1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

1024.3 Non-Bridge Deck Concrete Spall Repair:

A. Deep spall or delamination repair. ASTM C881, Type V, Meet grade requirements in Table 1024.3-1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

B. Shallow spall repair.

1. Concrete Adhesive. ASTM C881, Type V, Meet grade requirements in Table 1024.3-1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.
2. Tap Con Screws as recommended by manufacturer.

Table 1024.3-1: Grade Requirements for Concrete Spall Repair Material

Surface Orientation	Grade
Horizontal	Grade 2
Vertical or Angled	Grade 3

1024.4 Non-Bridge Deck PCC Masonry Rehabilitation:

A. ASTM C881, Type V, meet grade requirements in Table 1024.3-1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

1024.5 Dowel Bar Anchorage for PCC Pavement:

A. ASTM C881, Type IV, Grade 3. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

1024.6 PCC Overlays:

A. Provide concrete adhesive meeting either 1 or 2:

1. ASTM C881, Type V, meet grade requirements in Table 1024.3-1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.
2. ASTM C1059, Type II.

1024.7 Structure Construction Joints:

A. ASTM C881, Type V, meet grade requirements in Table 1024.3-1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

1024.8 Pavement Hole Filler:

A. ASTM C881, Type I, Grade 1. Provide Class of material in accordance with ASTM C881 and the temperature of the surface of the hardened concrete to which the bonding system is to be applied.

SECTION 1025 – ULTRA HIGH-PERFORMANCE CONCRETE

1025.1 Mix Requirements

A. Premix and proportion fine aggregate and cementitious materials in bags or supersacks. Supply dry components of the UHPC mixtures from a single UHPC material manufacturer. All materials must come from the same batch or lot.

1025.2 Material Properties

A. UHPC Closure Pours:

Table 1025.2-1. UHPC Closure Pour Material Properties

Description	Test Method	Acceptance Criteria
Compressive Strength	AASHTO T 22 (3”x6” cylinders) (150 psi/sec loading rate)	≥ 22 ksi @ 28 days
Shrinkage	AASHTO T 160 / ASTM C 157	≤ 800 micro-strain
Rapid Chloride Ion Penetrability or Surface Resistivity Testing	AASHTO T 277 / ASTM C 1202 or AASHTO TP 95	≤ 350 coulombs
Chloride Ion Penetrability	AASHTO T 259 (½” depth)	< 0.1183 lbs/yd^3
Scaling Resistance	ASTM C 672	Y < 3
Freeze-Thaw Resistance	AASHTO T 161 / ASTM C 666A (300 cycles)	Relative Dynamic Modulus of Elasticity > 95%
Alkali-Silica Reaction	ASTM C 1567 (Modified)	≤ 0.08% at 28 days
Slump Flow and Visual Stability	ASTM C1437 / ASTM C 1611	7 inches (Minimum) 10 inches (Maximum) No bleed water Consistent fiber distribution

1025.3 Acceptance Testing

A. At least 60-days prior to the placement of UHPC, submit a prepackaged batch of dry ingredients and admixtures sufficient for the Department to make a 1-cubic-foot trial batch of UHPC. The Department will perform testing for alkali-silica reaction or permeability on specimens without steel reinforcement. Batch proportions will otherwise remain the same per the prepackaged blend and water to cementitious materials ratio (w/cm).

B. Notify the Materials and Research Section a minimum of 48-hours prior to the anticipated UHPC placement.

C. Cure field-fabricated specimens in accordance with ASTM C31 and as modified by ASTM C1856 prior to collection by the Materials and Research section.

D. The Materials & Research section will test for following acceptance criteria:

Table 1025.3-1. UHPC Acceptance Testing

Description	Test Method	Criteria	Frequency
Compressive Strength	ASTM C39 as modified by ASTM C1856	≥ 22 ksi @ 28 days ≥ 14 ksi @ 4 days	Once per 25 CY or once per 12 hour shift
Rapid Chloride Ion Penetrability or Surface Resistivity Testing	AASHTO T 277 / ASTM C 1202 or AASHTO TP 95	≤ 350 coulombs	1 per job (Performed prior to field placement)
Slump Flow and Visual Stability	ASTM C1437 as modified by ASTM C1856	7 inches (Min.) 10 inches (Max.) No bleed water Consistent fiber distribution	1 per batch

SECTION 1030 — BAGGED RIPRAP

1030.1 Material Requirements.

A. Provide pre-mixed bagged riprap in accordance with the following:

1. PCC	See below and Section 1022
2. Portland Cement	Section 1020
3. Water	Section 1021
4. Fine Aggregate	Section 1003
5. Bags	See below

1030.1.1 Portland Cement Concrete.

Use a concrete mix that has a fine aggregate to cement ratio of 4:1 by weight. The contractor may substitute a dry mix of Class B concrete per Section 1022.

1030.1.2 Bags.

Use multi-wall perforated paper bags, perforated on approximate 1-inch centers, woven polyester, or polypropylene mesh bags that meet the following requirements:

A. Allow passage of water but not material leakage. Do not use paper bags for underwater applications.

B. Has an adequate seal, thickness, and strength to maintain the integrity of riprap until the concrete sets.

C. Is uniform in size and rectangular in shape.

D. Is consistent in color and blend with its environment and as required by the contract.

E. Disintegrates with no environmental damage.

F. Filled bag weight should be between 60-pounds and 90-pounds. Approximate size and capacity limits are shown in the table below:

Table 1030.1-1. Approximate Size and Capacity of Riprap by Bag Type

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

1031.1 Reinforced Concrete Pipe Culverts.

A. Provide reinforced circular concrete pipe in accordance with AASHTO M170/ M170M. Use Class III pipe unless specified otherwise on the contract.

B. Provide reinforced concrete elliptical pipe in accordance with AASHTO M207/ M207M.

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 in the contract.

C. Provide reinforced concrete flared end sections in accordance with:

1. Concrete and steel reinforcement used in circular flared end sections must comply with AASHTO M170 Class III requirements.
2. Concrete and steel reinforcement used in elliptical flared end sections must comply with AASHTO M207 Class III requirements.

D. Provide flexible watertight gasketed joints in accordance with ASTM C443 for pipe sizes constructed for use with rubber gaskets:

1. Ensure gasketed joints remain flexible and capable of withstanding expansion, contraction, and settlement of the pipe.
2. Store rubber gaskets at 70 degrees F or less.
3. Lubricate rubber gaskets requiring lubrication with the lubricant recommended and supplied by the manufacturer.

E. Provide a watertight joint using performed flexible bitumen or butyl sealant in accordance with ASTM C990 for pipe sizes constructed where gaskets are not applicable.

F. Do not ship pipe from the plant to the project until meeting the requirements of AASHTO M170/ M170M or AASHTO M207/ M207M and the pipe is marked with the production facility's quality control stamp. Mark the following information clearly on the pipe before inspection:

1. Pipe class and dimensions;
2. Pipe type – HE or VE, elliptical pipe only;
3. Date of manufacture; and
4. Name or trademark of manufacturer.

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 defective or damaged.

1031.2 Thermoplastic Pipe.

A. Provide polyethylene pipe, couplings, and fittings in accordance with AASHTO M294 for pipe sizes 12 inches and larger. Verify compliance through the AASHTO Product Evaluation & Audit Solutions.

B. Provide polyethylene pipe, couplings, and fittings in accordance with AASHTO M252 for pipe sizes smaller than 12 inches. Verify compliance through the AASHTO Product Evaluation & Audit Solutions.

C. Provide polyethylene flared end sections in accordance with ASTM D3350 meeting a minimum cell classification of 213320C. Verify compliance through the AASHTO Product Evaluation & Audit Solutions.

D. Provide joints for all pipes and fittings that use a watertight bell/spigot or bell/bell coupler in accordance with ASTM F477. Supply a joint system certified to meet a 10.8 PSI laboratory test per ASTM D3212.

E. Provide PVC pipe in accordance with AASHTO M278, AASHTO M304, ASTM F679, or ASTM F794.

F. Provide fiberglass pipe in accordance with ASTM D3262.

G. Provide polypropylene pipe, couplings, and fittings in accordance with AASHTO M330 for pipe sizes 12 inches and larger. Verify compliance through the AASHTO Product Evaluation & Audit Solutions.

1031.3 Steel Reinforced Thermoplastic Pipe.

A. Provide steel reinforced thermoplastic pipe in accordance with AASHTO M335.

1031.4 Pipe for Utility Work

A. Use materials in accordance with the utility owner's specifications. The utility owner has the right to inspect materials and reject any materials that do not meet the utility owner's specifications.

SECTION 1032 — PILE MATERIALS

1032.1 Description.

A. Provide materials for treated timber, cast-in-place concrete, steel H, and precast, prestressed concrete piles and test piles. Provide materials for galvanized steel sheet piles.

1032.2 Timber Pile Materials.

1032.2.1 Preparation

A. Provide treated timber piling in accordance with AASHTO M168, ASTM D25 and AWPA U1; Commodity Specification E: Round Timber Piling; UC4C. When piles are directly immersed in tidal salt water, provide pile in accordance with AWPA U1; Commodity Specification G: Marine (Salt Water) Applications; UC5C.

1032.2.2 Inspection.

A. In accordance with Section 1041.4.

1032.2.3 Storing and Handling.

A. In accordance with Section 605.

1032.3 Cast-in-place Concrete Pile materials.

1032.3.1 Steel Shells.

A. Use fluted steel pile shells for cast-in-place concrete piles, unless the contract indicates use of steel pipe pile shells.

B. If using steel pipe piles, use steel pipe pile shell in accordance with ASTM A572, Grade 50 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 can also be used. 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 shells. A maximum 1/4-inch protrusion is permissible. If the protrusion exceeds 1/4-inch, grind the protruding weld flush with the outside surface of the pile shell.

C. If using fluted steel pile shells, provide a tapered section as shown in the contract. 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 3/4-inch fillet weld. Perform welding with AWS certified welders, approved by the Department. Maintain current welding certifications current and show passing qualifications for the type of welding performed. Use steel shells conforming to SAE 1010 or 1015 and having a minimum yield point of 50,000-PSI, and a minimum thickness of 7-gage.

D. Construct all field splices to have the full strength of the sections the splices connect. Keep a minimum distance of 40-feet between field splices when possible. Obtain approval from the engineer for all field splices.

1032.3.2 Protective Coating.

A. When indicated on the contract, protect the steel shells with a coating consisting of either coal tar epoxy or fusion bonded epoxy.

B. If the specifications require a coal tar epoxy coating, apply 2 coats of dark red coal tar epoxy. Thoroughly dry and commercially blast clean the pile shell in accordance with SSPC-SP 6 before coating. Perform the two-coat application, final drying time, touch-up, and inspection in accordance with the specifications of the SSPC. Provide a dry film thickness of each coat of 8 mils minimum and 16-mils maximum for the two-coat system.

C. If specifications indicate the use of a fusion bonded epoxy coating, provide a 1-part, heat curable, thermosetting powder coating, meeting the following requirements:

Table 1032.3-1. Fusion Bonded Epoxy Coating Requirements

Property	Test Method	Value
Gloss 60°	ASTM D523	25 to 90%
Impact (5/8" Top) [16 mm Top]	ASTM G14	80-160 Inch Pounds (9 to 18 J)
Taber Abrasion*	ASTM D4060	70 mg/1,000 Cycles
Chemical Resistance	ASTM D1308	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, 1,000 g load, 1,000 cycles.

D. Apply the fusion bonded epoxy coating in a fully enclosed environmentally controlled plant. Use a blast cleaning apparatus and coating application system approved and prequalified by the Department before use. Blast clean all surfaces coated in accordance with SSPC-SP 5 White Metal Blast Cleaning Standards. Achieve a blast profile of 2 to 3 mils. Measure the surface profile in accordance with ASTM D4417. Submit a repair procedure should the blast profile exceed the requirements. Apply the coating within 8 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 D7091.

E. Provide a compatible touch-up compound for repairing areas damaged during driving for coal tar and fusion bonded epoxy coatings. Apply the touch-up compound to all visible open areas, in accordance with the manufacturer's recommended procedures.

F. When specifications require the use of a protective coating for the production piles, apply a protective coating to the entire length of each pile, test pile, and production pile.

1032.3.3 PCC.

A. Use Class A PCC in accordance with Section 1022.

1032.3.4 Bar Reinforcement.

A. Use bar reinforcement in accordance with Section 611.

1032.3.5 Storage and Handling.

A. Store and protect the steel shells to avoid dents, abrasions, and other injuries, and pick up in a manner that will avoid bending and distortion. The engineer will reject pile shells damaged by improper storage or handling.

1032.3.6 Inspection.

A. The Department will inspect steel shells at the point of shipment before application of any protective coating. If using a required protective coating, the plant will inspect the application of the coating. The pile shells remain subject to inspection at the project site before driving. All defective piles will result in rejection.

1032.4 Steel H Pile Materials.

1032.4.1 Material Requirements.

A. Submit mill certifications for approval. Unless otherwise indicated, use only steel H piles in accordance with ASTM A709, Grade 50. Use the same materials for splices or reinforced tips as the H pile except that cast steel may suffice for tips. Perform welding in accordance with Section 1039. Use steel that is straight and true within the permissible mill tolerances.

1032.5 Precast, Prestressed Concrete Pile Materials.

1032.5.1 PCC.

A. Use PCC for square prestressed concrete piles conforming to the requirements of Sections 610, 612, and 1022. A 28-day compressive strength of 6,000-PSI is required unless noted otherwise on the contract. Develop and submit the concrete mix design for approval in accordance with Section 1022.

1032.5.2 Prestressing Strands.

A. Provide 1/2-inch prestressing strands in accordance with Section 1038. Arrange the strands in accordance with the contract and stress in accordance with Section 612.3.4.

1032.5.3 Spiral Reinforcing.

A. Use spiral reinforcing in accordance with AASHTO M336.

1032.5.4 Bar Reinforcement.

A. Use bar reinforcement, if required, in accordance with Section 611.

1032.5.5 Fabrication.

A. Provide piles with flat tips as indicated in the contract. Pointed pile tips are not permitted, unless specifically called for in the contract. Provide prestressed concrete piles within the following allowable tolerances:

Table 1032.5-1 Prestressed Pile Tolerances

Prestressed Pile Feature	Tolerance
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”

1032.6 Steel Sheet Pile Materials.

1032.6.1 Material Requirements.

A. Submit mill certifications for approval. Provide steel sheet piles in accordance with AASHTO M202.

B. Galvanize steel sheet piles in accordance with Section 1039.10.

C. The contractor may propose to use an alternate cold-formed or hot-rolled steel sheet pile shape and size instead of using the steel sheet pile shape and size specified in the contract. Submit to the engineer working drawings showing all details of the alternate steel sheet for review. The alternate steel sheet pile size must have a section modulus greater than or equal to the steel sheet pile size specified in the contract. The Department is not obligated to approve alternate steel sheet pile shapes and sizes.

D. There will be no additional payment if the engineer approves the alternate steel sheet pile shape and size.

1032.7 Friction Reducing Jackets.

1032.7.1 Material Requirements.

A. When allowed by the Plans, the contractor may propose to use an alternate system for reducing the friction on a pile from the surrounding embankment or MSE wall being constructed. The Plans will specify allowable manufacturers and products. Submit to the engineer working drawings showing all details of this alternate system for review and approval. There will be no additional payment if the engineer approves the alternate friction reducing system.

B. The system must consist of preformed yellow thermoplastic polymer (3-4 mm) friction reducing corrugated pile jackets lubricated during the thermoset manufacturing process. The jacket must be comprised of a solid lubricating layer fabricated and customized to fit the pile cross-section. H-pile jackets may be manufactured in one-piece or two-piece systems. Both systems shall have a positive means of interlocking or fastening itself about the pile to properly stay in place during backfilling and compaction operations. For pipe pile and concrete pile installations, jackets may be lapped and duct-taped into place. Friction jackets shall be installed to coincide with the tiered lifts of the MSE wall or embankment construction process and lapped a minimum of 2-inches over the previous installed jacket mounted on the pile. The starter jacket will begin at the elevation as set forth in the Plans and should coincide with the elevation of the bottom of the embankment or MSE wall backfill material.

SECTION 1033 — ACCESS TUBES FOR CROSSHOLE SONIC LOG TESTING

1033.1 Material Requirements.

A. Use steel pipe of 0.145-inches minimum wall thickness and at least 1 1/2-inch inside diameter for access tubes for crosshole sonic log testing. Do not use galvanized steel access tubes unless approved by the engineer.

B. Use access tubes having a round, regular inside diameter free of defects and obstructions, including all pipe joints, to permit the unobstructed passage of 1.3-inch maximum diameter source and receiver probes used for the crosshole sonic log tests. The access tubes must remain 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

1034.1 Material Requirements.

A. Provide permanent structural casings made of steel conforming to ASTM A572, Grade 50 unless specified otherwise in the contract. Splice permanent structural casing in accordance with Section 6 of the AASHTO LRFD Bridge Design Specifications.

B. The diameter of permanent casings will be as shown in the contract. If the engineer approves a larger size permanent casing, no additional payment will result for the increased weight of casing steel or the increased quantity of drilled shaft excavation and concrete.

C. All permanent casings 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. Corrugated casing may be used for permanent nonstructural casing if approved by the engineer.

D. The contract specifies the minimum thickness of the casing to satisfy structural design requirements. The contractor may need to increase the casing thickness from the specified thickness to satisfy the construction installation requirements.

E. Provide temporary casings with smooth wall structure steel except where corrugated metal pipe is shown in the contract as an acceptable alternative material. Provide temporary casings 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. Provide a casing capable of being removed without deforming and causing damage to the completed shaft or disturbing the surrounding soil.

F. Provide a temporary casing with an outside diameter greater than or equal to the specified diameter of the shaft. Provide casings that are watertight and clean before placement in the excavation.

G. Completely remove temporary casings unless otherwise shown on the contract or approved by the engineer.

SECTION 1035 — SLURRY

1035.1 Mineral Slurry.

A. Use mineral slurry in conformance with the drilled shaft installation plan in accordance with Section 606.3.1.B. Use a mineral slurry conforming to the following requirements:

Table 1035.1-1 Mineral Slurry Requirements

Property	Test Method (Slurry Temperature ≥ 40°F at time of 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 before 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.

1035.2 Polymer Slurry.

A. Use polymer slurries, either natural or synthetic, in conformance with the manufacturer's recommendations, and conform to the drilled shaft installation plan in accordance with Section 606.3.1.B.

B. The polymer slurry must conform to the following requirements:

Table 1035.2-1. Polymer Slurry Requirements

Property	Test Method (Slurry Temperature ≥ 40°F at time of test)	Requirement
Density (pcf)	Mud Weight (Density) API RP 13B-1, Section 1	64[1] 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 before placing concrete	API RP 13B-1, Section 5	1.0 max[2]

[1]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.

[2]The sand content of polymer slurry before final cleaning and immediately before placing concrete must be less than or equal to 1.0 percent, in accordance with American Petroleum Institute RP 13B-1, Section 5.

1035.3 Water Slurry.

A. 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.

B. Water slurry must conform to the following requirements:

Table 1035.3-1. Water Slurry Requirements

Property	Test Method (Slurry Temperature ≥ 40°F at time of 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 1037 — EMBEDDED REINFORCEMENT AND HARDWARE

1037.1 Uncoated Reinforcement.

A. Provide billet-steel bar reinforcement in accordance with AASHTO M31, Grade 60.

B. Provide deformed steel wire in accordance with ASTM A1064.

C. Provide welded plain steel wire fabric in accordance with ASTM A1064.

D. Provide plain steel wire in accordance with ASTM A1064.

E. Provide deformed steel welded wire reinforcement in accordance with ASTM A1064.

F. Provide zinc alloy wire in accordance with ASTM A1055.

1037.2 Coated Reinforcement.

A. Provide epoxy-coated bar reinforcement in accordance with ASTM A775, ASTM D3963, and AASHTO M31, Grade 60.

B. Provide epoxy-coated wire and welded wire fabric in accordance with ASTM A884, Class A.

C. Provide a certificate of compliance with each shipment of epoxy-coated reinforcing steel. The certificate of compliance must be signed by the coating applicator certifying that the above requirements are met.

D. Provide galvanized bar reinforcement in accordance with ASTM A1094 or ASTM A767 with a zinc coating conforming to ASTM B6.

1037.3 Stainless Steel Reinforcement.

A. Provide stainless steel bar reinforcement in accordance with ASTM A955, Grade 60. Do not mix multiple stainless steel types on the same project.

1037.4 Pavement Hardware.

A. Provide tie bars in accordance with AASHTO M31, Grade 60 or AASHTO M322, Grade 60. Do not use rail-steel for tie bars that will be bent and re-straightened during construction.

B. Provide Coated Dowel Bars in accordance with AASHTO M31 and ASTM A775 Type A or Type B as referenced on the contract.

C. Provide hook bolts and w-bolts in accordance with AASHTO M31, Grade 60.

1037.5 Other Hardware.

A. Provide splice couplers in accordance with AASHTO M31, Grade 60.

B. Provide epoxy coated splice couplers in accordance with AASHTO M31, Grade 60 and ASTM A775.

SECTION 1038 — PRESTRESSING STRANDS

1038.1 Material Requirements.

A. Unless otherwise indicated in the contract, 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

1038.1.1 Uncoated Strands.

A. Use prestressing strands that are uncoated high-strength 7-wire low-relaxation strand, with nominal 0.5-inch or 0.6-inch diameter (referred to as strand designation no. 13 and 15 in AASHTO M203) in accordance with the contract and AASHTO M203, Grade 270, low-relaxation. Do not use stress-relieved type strands.

1038.1.2 Post-Tensioning Strands.

A. Use 1/2-inch diameter, 7-wire, uncoated, low-relaxation strands for unbonded post-tensioning conforming to AASHTO M203 Grade 270. Encase strands in polymer sheathing. Use a corrosion inhibitor recommended by the manufacturer between the strand and sheathing. Provide anchorages, bearing devices, fittings, and couplings as shown on the contract and specified by the tendon manufacturer.

SECTION 1039 — STRUCTURAL STEEL

1039.1 Structural Steel.

A. General. Provide the grade or grades of steel in accordance with the contract.

1. Ensure that the steel used in the main load carrying member components that are subject to tensile stress meets the applicable AASHTO M270 Charpy V-notch Impact Test requirements for Zone 2 unless otherwise specified.

B. Carbon Steel. For carbon steel, meet AASHTO M270, Grades 36 or 50S.

C. High-Strength, Low-Alloy Structural Steel. For high-strength, low-alloy structural steel, meet AASHTO M270, 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 M270, Grade 70W.

E. High-Yield-Strength, Quenched-and-Tempered Alloy Steel Plate. For high-yield-strength, quenched-and-tempered alloy steel plate, meet AASHTO M270, Grades 100 or 100W.

1. For quenched-and-tempered alloy steel structural shapes and seamless mechanical tubing, meet AASHTO M270, Grade HPS 100W steel, except that the specified maximum tensile strength is 140,000 PSI for structural shapes and 145,000 PSI 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 M270, Grades HPS 50W, HPS 70W, or HPS 100W.

G. Steel for Eyebars. For eyebars, meet AASHTO M270, Grades 36, 50, 50W, or HPS 50W.

H. Shim Plates. For shim plates, use steel plates in accordance with AASHTO M270, Grade 36.

1039.2 Fasteners.

A. Bolts for General Application. For general application bolts, meet ASTM A307, Grade A.

1. U-Bolts. ASTM A449, Type 1.

B. Nuts. For nuts, meet ASTM A563.

C. Washers. For washers, meet ASTM F436 or ANSI B18.22.

D. Hardware for Wood Connectors. For wood connector hardware, meet ASTM A711 or AISI no. 1015.

E. Direct Tension Indicators. Use direct tension indicators (DTIs) conforming to ASTM F959 for bolts with a diameter of 1 1/2-inch or less and ASTM F2437 for bolts with diameter greater than 1 1/2-inch when specified in the contract.

1039.3 High Strength Fasteners.

A. High Strength Bolts and Bolting Materials. For structural steel joints, provide high-strength bolts that meet ASTM F3125, Grade A325 or Grade A490. Ensure that the hardness of Grade A325 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.

B. 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 F606, Method 1.
2. Wedge tension tests of full-size bolts performed according to ASTM F606.
3. Proof load tests of nuts as required by ASTM A563.

C. Ensure galvanized bolts are wedge tested after galvanizing. Perform proof load tests for nuts used with galvanized bolts after galvanizing, overtapping, and lubricating.

D. For ASTM A3125 Grade A325 bolts, provide nuts meeting ASTM A563, Grades C, C3, D, DH, or DH3.

E. For ASTM A3125 Grade A490 bolts, provide nuts meeting ASTM A563, Grades DH or DH3.

F. Do not use DH3 nuts with Type 1 bolts.

G. Lubricate galvanized nuts with a lubricant containing a visible dye. Ensure black bolts remain oily to the touch when delivered and installed.

H. Provide washers of hardened steel meeting ASTM F436.

I. Stainless Steel Bolts and Nuts. Provide bolts meeting ASTM F593, alloy groups 1, 2, or 3, and nuts meeting ASTM F594.

J. Identifying Marks.

1. Ensure ASTM F3125, Grade A325 fasteners have the following markings, as applicable.
   a. Bolts and Nuts. Mark bolt heads to identify the grade (by the symbol “A325”), the manufacturer, and the type. Mark nuts to identify the grade, the manufacturer, and the type.
   b. Direct Tension Indicators. Mark direct tension indicators to identify the manufacturer and the type.
   c. Washers. Mark washers to identify the manufacturer and the type.
2. Ensure ASTM F3125, Grade A490 fasteners have the following markings, as applicable.
   a. Bolts and Nuts. Mark bolt heads to identify the grade (by the symbol “A490”), the manufacturer, and the type. Mark nuts to identify the grade, the manufacturer, and the type.
   b. Direct Tension Indicators. Mark direct tension indicators to identify the manufacturer and the type.
   c. Washers. Mark washers to identify the manufacturer and the type.

K. 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.

L. Galvanizing. Perform in accordance with Section 1039.10 and in accordance with herein.

1. Do not galvanize ASTM F3125, Grade A490 bolts.

2. For ASTM F3125, Grade A325, Type 1 fasteners, mechanically galvanize according to ASTM B695, Class 55.
3. Tension test bolts after galvanizing.

M. Alternate Fasteners. Obtain approval to use fasteners or fastener assemblies that differ from the contract. Ensure that alternate fasteners meet the materials, manufacturing, and chemical composition requirements of ASTM F3125, Grade A325 or A490 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.

1. Approved alternate fasteners may differ in other dimensions from those of the specified bolts and nuts.
2. 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:
   i. The shank and head meet the requirements of Section 1039.2.A.
   ii. Each fastener provides a solid shank body of sufficient diameter to provide tensile and shear strength equal or greater than that of the bolt specified.
   iii. A cold-forged head on 1 end, of adequate type and dimensions.
   iv. A shank length suitable to fasten the material, locking grooves, breakneck groove, and pull grooves (all annular grooves) on the opposite end.
   v. 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 removal of the pull groove section has been removed.
   vi. The steel locking collar is a standard product of an established manufacturer of lock pin and collar fasteners.

1039.4 Anchor Bolts.

A. Anchor Bolts. For anchor bolts, meet AASHTO M314, Grades 36, 55, 105. Mechanically galvanize in accordance with Section 1039.10.

B. Nuts. For nuts, meet ASTM A563.

C. Washers. For washers, meet ASTM F436.

1039.5 Welded Shear Connectors.

A. Materials. Provide stud shear connectors meeting the requirements of AASHTO M169, cold drawn bars, UNS designations G 10150, G 10180, or G 10200, either semi- or fully-kilned. When using flux retaining caps, ensure that the steel used for the caps is a low-carbon grade suitable for welding and that meets ASTM A109 requirements.

B. Meet Table 1039.5-1 requirements with bar stock used to produce finished studs. Determine yield by the 0.2 percent offset method.

Table 1039.5-1. Tensile Properties of Stud Sheer 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%

C. Dimensions. Provide stud shear connectors meeting the dimensions of Table 1039.5-2.

Table 1039.5-2. Stud Shear Connectors Standard Dimensions and Tolerances (in inches)

Shank Diameter (c)	Length* (L)	Head Diameter (H)	Thickness (T)
0.75 (+0.000 to -0.015)	6 (+0.062 to - 0.125)	1.25 (+0.015)	0.375 minimum
0.875 (+0.000 to -0.015)	6 (+0.062 to -0.125)	1.75 (+0.015)	0.375 minimum

*Length includes thickness of head.

D. Test Methods. Determine tensile properties according to the applicable sections of AASHTO T244. 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.

E. Finish. Provide 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.

F. Certification. Provide the manufacturer's certification that the delivered studs meet material requirements. Provide certified copies of in-plant quality control test reports with delivered product.

G. 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.

1039.6 Steel Forgings and Steel Shafting

A. Steel Forgings. For steel forgings, meet AASHTO M102, Classes C, D, F, or G.

B. Cold-Finished Carbon Steel Shafting. For cold-finished carbon steel shafting, meet AASHTO M169, Grades UNS designations G 10160 to G 10300, inclusive.

1039.7 Castings.

A. Steel Castings.

1. Capable of meeting or exceeding an HS-25 load rating when tested in accordance with AASHTO M306.
2. Conforming to the manufacture requirements of AASHTO M306.
3. Steel Castings. For steel castings, meet AASHTO M103, Grade 70–36.
4. Chromium Alloy Steel Castings. For chromium alloy steel castings, meet AASHTO M163, Grade CA 15M.

B. Iron Castings.

1. Capable of meeting or exceeding an HS-25 load rating when tested in accordance with AASHTO M306.
2. Conforming to the manufacture requirements of AASHTO M306.
3. Gray Iron Castings. For gray iron castings, meet AASHTO M105, class 35B.
4. Ductile Iron Castings. For ductile iron castings, meet ASTM A536, Grade 60-40-18. Inlet and manhole castings (covers, frames, and grates) meet ASTM A536 Grade 80-55-06. Provide 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.
5. Malleable Iron Castings. For malleable iron castings, meet ASTM A47, Grade 32510.
6. Clean scale and sand from all castings before delivery.

1039.8 Pipe and Tubing.

A. Steel Pipe.

1. Pipe and Couplings. For pipe and couplings, meet ASTM A53.
2. Flanges and Pipe Fittings. For flanges and pipe fittings, meet ASTM A338.
3. Weld Fittings. For weld fittings, meet ASTM A234.

B. Low-Alloy Steel Pipe.

1. Pipe and Couplings. Manufacture pipe and couplings from low-alloy steel AASHTO M270, Grade 50 or 50W, Type 2 or AASHTO M270 Grade 50W, and conforming to ASTM A53.
2. Flanges and Pipe Fittings. For flanges and pipe fittings, meet ASTM A338.
3. Welding Fittings. For weld fittings, meet ASTM A234.

C. Cast Iron Pipe. For cast iron pipe, meet ASTM A74 or ASTM A377.

D. Steel Tubing. For steel tubing, meet ASTM A500 or ASTM A501.

E. Sign Structure Pipe. For sign structure pipe, meet 1 of the following:

1. ASTM A53, Grade B, Type E or S:
   a. Provide Charpy V-notch testing (zone 2) for pipe with wall thicknesses greater than or equal to 1/2-inch.
2. API Specification 5L PSL2 Grade B X42, X42M, X52, or X52M:
   a. No jointers permitted.
   b. Process of manufacture: seamless, electric resistance welded, or longitudinal seam, submerged arc welded.
   c. Provide Charpy V-notch testing (zone 2) for pipe with wall thicknesses greater than or equal to 1/2-inch.
3. ASTM A500, 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 A106, Grade B:
    a. Provide Charpy V-notch testing (zone 2) for pipe with wall thicknesses greater than or equal to 1/2-inch.

1039.9 Metal Sheeting.

A. Metal Bridge Deck Forms. Use permanent forms, fabricated from steel conforming to ASTM A924 and ASTM A653 (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 A153 or ASTM B633, thickness class Fe/Zn 12.

B. Sheet Copper. For sheet copper, meet ASTM B152, and conform to the requirements of the Embrittlement test, Section 12 of ASTM B152 and ASTM B577. Make lapped joints by soldering or by riveting.

C. Sheet Zinc. For sheet zinc, meet ASTM B69, Type II. Make lapped joints by soldering.

D. Steel Sheet. For steel sheet, meet ASTM A653 designation G-90.

1039.10 Galvanizing.

A. General.
    1. If indicated or specified, galvanize materials in accordance with the applicable material specifications. If the applicable material specifications do not include galvanizing, galvanize according to: AASHTO M111, AASHTO M232, ASTM B633, ASTM A392 Class 2 coating, or ASTM B695, as applicable.
    2. Test for the specified weight of galvanizing according to AASHTO T65.
    3. Comply with ASTM A143 and ASTM A385.

B. Repair of Damaged Galvanizing. Repair damaged galvanizing in accordance with ASTM A780.

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

1040.1 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 C62, Grade SW or architectural brick meeting ASTM C216. 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 C902, Class SX, Type 1.
4. Vehicular Paving Brick. For vehicular paving brick, meet ASTM C1272.

1040.2 Concrete Brick.

A. For concrete brick, meet ASTM C55 for the grade specified.

1040.3 Concrete 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 C139 or C90, 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. Use a minimum compressive strength of 2,000 PSI for units less than 5 inches in thickness. Use hollow blocks meeting ASTM C90. Comply with the dimensions specified.

B For architectural segmental retaining walls, use rectangular or segmented block meeting the requirements of ASTM C1372.

1040.4 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 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.

1040.5 Dimensional Stone.

A. Limestone dimensional stone. For limestone dimensional stone, meet ASTM C568.

B. Granite dimensional stone. For granite dimensional stone, meet ASTM C615.

C. Quartz based dimensional stone. For quartz based dimensional stone, meet ASTM C616.

D. Slate dimensional stone. For slate dimensional stone, meet ASTM C629.

SECTION 1041 — WOOD

1041.1 Definitions.

A. Lumber – Wood that has been sawn or otherwise processed into useful sizes and dimensions. This includes nominal dimensioned boards (3/4-inch to 1 1/2-inch thick) and structural lumber (2-4 inches thick).

B. Timber – Sawn or otherwise processed wood of nominal dimension 5-inch x 5-inch and larger.

C. Rough Sawn – Sawn lumber or timber that has not been dressed but has been edged and trimmed.

D. Dressed – Lumber or timber that has been planed (surfaced).

1041.2 Sawn Wood.

A. Manufacture sawn wood products meeting AASHTO M168 of the species, grade, and finish (rough sawn or dressed) specified by the contract. If none is specified, provide southern yellow pine or Douglas fir, no. 1 grade or better, cut square and surfaced on 4 sides.

1041.3 Structural Glued, Laminated Timber.

A. Manufacture structural glued laminated timber of the sizes, shapes, and engineering properties indicated by the contract, according to ANSI/AITC A-190.1. If the wood species is not specified, use kiln-dried Douglas fir or southern yellow pine.

B. As employed in ANSI/AITC A-190.1, 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.

1041.4 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 M133 and American Wood Protection Association (AWPA) standards, U1 and T1, and the following limitations. Do not use the preservatives interchangeably:

1. Upon completion of treatment, 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 lumber used for highway construction and maintenance applications for sign posts, fence posts, gates, stair treads, and general applications with preservatives specified in AASHTO M133 or in accordance with AWPA standard U1: commodity specifications A (sawn products) or B (posts); UC4A.

5. Treat lumber and timbers used for highway construction and maintenance applications for guardrail posts, offset blocks, bridge decking, structural glue laminated timbers, and composites with preservatives specified in AASHTO M133 or in accordance with AWPA standard U1: commodity specifications A (sawn products), F (wood composites); UC4B. For items that are immersed in salt or tidal salt water, use preservatives specified in AWPA U1 Commodity Specification: (marine {salt water} applications); UC5C. With any wood preservative chemistry, always use fasteners or connectors with either 304 or 316 stainless-steel or hot-dipped galvanized, in accordance with the requirements of ASTM A153 or ASTM A653, Class G 185. Do not use mechanically galvanized steel. Washers and nuts should be of the same hot-dipped galvanized coating or stainless steel as the bolts.
6. Treat with either alkaline copper quarternary (ACQ), copper azole (CA), or micronized copper azole (MCA) preservative wood for hand-contact surfaces such as handrails, playground equipment, and picnic tables as specified in AWPA U1. With any wood preservative chemistry, always use fasteners or connectors with either 304 or 316 stainless-steel or hot-dipped galvanized, in accordance with the requirements of ASTM A153 or ASTM A653, Class G 185. Do not use mechanically galvanized steel.
7. Treat according to the following practices:
    a. Perform the preservation treatment process in conformance with the applicable requirements of AWPA Standard T1.
    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 or 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 an ALCS accredited independent third-party agency. The engineer may require the treated items not bearing the quality mark to be inspected 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. Perform inspections at the plant according to AASHTO M133 or AWPA standards. A treater participating in the ALSC Treated Wood Program and monitored by an approved inspection agency, or an independent commercial inspection agency approved by the engineer. The contractor may engage the inspection agency either directly or through the supplier.

D. Certificate of Compliance. Accompany each shipment with a manufacturer's certificate of compliance and inspection report. Identify the preservative used, the specification required, and the test results. Certificate of compliance must include the treater or the qualified independent inspection agency signatures.

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."

1041.5 Wood Connectors and Hardware.

A. Connectors. Meet Section 1039.2.

B. Rods, plates, eyebars, and shapes. Meet Section 1039.

C. Cast steel or gray iron castings. Meet Section 1039.7.

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 cut or round wire standard form nails. Provide spikes that are cut or wire spikes, or boat spikes, as specified. Use nails, spikes, bolts, dowels, washers, rods, plates, and lag screws that are galvanized according to the requirements of AASHTO M232. For glulam timber, provide all steel connections and all hardware for joining wood members to each other and to the substructure. Use galvanized mild steel AASHTO M270 hardware. With any wood preservative chemistry, always use fasteners or connectors with either 304 or 316 stainless-steel or hot-dipped galvanized, in accordance with the requirements of ASTM A153 or ASTM A653, Class G 185. Provide fasteners or connectors that will come into 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.

1. Do not use mechanically galvanized steel.

2. To prevent metallurgic reactions, in cases where fastener materials may contact each other use only one type of fastener material.

SECTION 1042 — JOINT/CRACK SEALANT MATERIAL

1042.1 Asphalt and PCC Pavements:

A. Crack Sealing. ASTM D6690 Type II.

B. Joint Sealing. ASTM D6690 Type II.

1042.2 PCC Curb and Integral Curb, Medians, Sidewalks and Pedestrian Connections:

A. Preformed Expansion Joint Material. AASHTO M153, Type I, II, or IV.

B. Joint Sealing. ASTM D6690 Type II.

1042.3 PCC Structures, General:

A. Preformed Elastomeric Compression Joint Seals. ASTM D2628.

B. Rubber Joint Sealant. Use the color gray to match the concrete.

1. Elastomeric Joint Sealant. ASTM C920, Type M.
2. Silicone Joint Sealant. ASTM D5893.

C. Hot Poured Joint Sealer. ASTM D6690 Type II.

D. Preformed Expansion Joint Material. AASHTO M153, Type I, II or IV.

1042.4 Bridge Deck Joints:

A. Prefabricated Expansion Joint System. ASTM D5973.

Provide galvanized steel conforming to ASTM D5973 and Section 1038

B. Asphaltic Plug Joint. ASTM D6297.

C. Silicone Joint Seal. ASTM D5893.

D. Compression Seal. ASTM D3542.

E. Silicone Coated Foam Joint Seal.

F. Provide a sealant system comprised of three components:

1. Cellular polyurethane foam impregnated with hydrophobic 100 percent acrylic, water-based emulsion, factory coated with highway-grade fuel resistant silicone.
2. Field-applied epoxy adhesive primer.
3. Field-injected silicone sealant bands.

1042.5 Precast Flexible Joint Sealant:

A. Bitumen sealant or butyl rubber sealant in accordance with ASTM C990.

B. Closed-cell Neoprene Sponge in accordance with ASTM 1056, Type 2, Class D.

SECTION 1043 — JOINT BACKUP MATERIAL

1043.1 Material Requirements.

A. Use joint sealing backup material of a stitched cotton piping cord, polyethylene backer rod, or approved equal material compatible with the sealant and capable of withstanding the required sealant application temperature without melting.

1. Stitched cotton piping cord	ASTM D5249
2. Backer rod	ASTM D5249

B. Before installation, provide back-up material 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 will support the sealant at its design depth, allow 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

1044.1 Aluminum materials.

A. General. Provide aluminum in accordance with the contract. 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 Plates or Sheets. Meet ASTM B209.

C. Aluminum Extrusions. Meet ASTM B221 or ASTM B308.

1044.2 Fasteners.

A. Aluminum Rivets. Meet ASTM B316.

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 M232, 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.

1044.3 Welding Requirements.

A. Meet AASHTO/AWS D1.2 Structural Welding Code—Aluminum.

1044.4 Aluminum Forgings.

A. Meet ASTM B247.

1044.5 Castings.

A. Aluminum Castings. Meet ASTM B26.

B. Aluminum-Alloy Permanent Mold Castings. Meet ASTM B108.

SECTION 1045 — CONCRETE COATINGS AND MEMBRANES

1045.1 Epoxy Coating.

A. Provide a high solids epoxy coating that complies with all VOC regulations.

B. Additional requirements are as follows:

Table 1045.1-1. Epoxy Coating Requirements

Requirement	Measurement
Minimum Solids Content	72% by Weight
Tensile Strength (ASTM D638)	>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. Use the color insignia white (federal color 37925 of AMS-STD-595A) unless specified otherwise on the contract.

1045.2 Silicone-Based Acrylic Coating.

A. Provide a sealer that consists of methyl methacrylate-ethyl acrylate copolymer resins and toning pigments suspended in solution at all times by a chemical suspension agent and solvent. Use laminar silicates, titanium dioxides, and inorganic oxide for toning pigments. Do not use vegetable or marine oils, paraffin materials, stearates, or organic pigments in the formulation.

B. Provide a sealer that is an opaque, non-film forming, and penetrating silicone acrylic compound. Provide a sealer that passes NCHRP 244 Series II: salt spray resistance requirements and complies with local VOC requirements.

C. Use the color insignia white (federal color 37925 of AMS-STD-595A) unless specified otherwise on the contract.

1045.3 Silane-Based Concrete Sealer.

A. Provide a silane based concrete sealer meeting the following requirements:

1. Applied through a one component system.
2. Contains a minimum of 40 percent silane by weight.
3. An alcohol-solvent suspension.
4. Does not alter the permanent color or texture of applied on PCC.
5. Meets the physical test requirements of Table 1045.3-1, when tested in accordance with the applicable test method provided.

Table 1045.3-1. Silane-Based Concrete Sealer Requirements

Property	Test Method	Requirement
Moisture Vapor Transmission	ASTM D1653	Minimum 98% in relation to uncoated specimen
Absorbed Chloride	NCHRP 244 Series IV Southern Exposure	Minimum 95% reduction
Water Absorption	NCHRP 244 Series II	Minimum 80% reduction
Depth of Penetration	OHD L-40	0.15” minimum
Total Solids Content	ASTM D5095	40% minimum

B. Tint material with a dye that enables visibility of the sealer for at least 4-hours after application. The dye must not remain visible more than 7 calendars days after application of the material.

1045.4 High Molecular Weight Methacrylate Sealer.

A. Provide 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 D2369 before adding initiator. The resin must also conform to the following:

Table 1045.4-1. High Molecular Weight Methacrylate (HMWM) Resin Properties

Property	Requirement	Test Method
Viscosity* (Brookfield RVT with UL adapter, 50 RPM at 77ºF)	25 cps, maximum	ASTM D2196
Specific Gravity* (at 77ºF)	0.90, minimum	ASTM D1475
Flash Point* (ºF)	180 minimum	ASTM D1310
Vapor Pressure* (at 77ºF)	0.0193 PSI maximum	ASTM D323
Tack Free Time (minutes at 77ºF)	400 min. maximum	ASTM C679
PCC Saturated Surface-Dry Bond Strength (at 24 hrs. at 70±1ºF)	700 PSI minimum	California Test CT551, Part 5

*Tested before adding initiator.

B. Use a prime coat promoter/initiator that consists of a metal drier and peroxide. If supplied separately from the resin, do not mix the metal drier directly with the peroxide as a violent exothermic reaction will result. Store the containers in a manner that will not allow leakage or spillage from 1 material to contact the containers or material of the other.

1045.5 Membranes.

A. Provide a waterproofing asphaltic membrane consisting of a woven or non-woven, needle punched composite membrane with a minimum thickness of 60-mils. Sandwich woven fiberglass reinforcement or non-woven, needle punched polypropylene between rubberized asphalt compound or adhesive membrane. The materials must have sufficient adhesive property or be applied with have primer tack coat. Use primer/tack adhesive materials that maintain compatibility with the asphaltic membrane. Use per manufacturer's recommendation.

B. Additional requirements for traffic bearing membranes:

Table 1045.5-1. Traffic Bearing Membrane Requirements

Property	Test Method	Standard
Strip Tensile	ASTM D882	50 lb./in min
Puncture Resistance	ASTM E154	200 lbs. min
Permeance	ASTM E96 Method B	0.10 perms (max)
Pliability	ASTM D146	No crack or split
Elongation	ASTM D882	50% minimum

C. Additional requirements for membranes not in traffic bearing situations:

Table 1045.5-2. Non-Traffic Bearing Membrane Requirements

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

1045.6 Aesthetic Stain

A. Provide a water based penetrating stain designed for exterior use. Provide a stain that is UV resistant, weather resistant, and breathable. Provide a stain that complies with all local VOC regulations.

B. Provide a stain with a composition meeting the requirements listed below.

Table 1045.6-1. Aesthetic Stain Composition

Property	Specification	Requirement
Solids Content by Weight	ASTM D2832	30% Minimum
Mildew Resistance	FED Test Method STD 141 Method 6271.2	Resistant
Weather Resistance	ASTM G7	Passing at 2 years
Color	AMS-STD-595A	Per contract
Drying time (to touch)	ASTM 1640	2 hours minimum

Drying time (to recoat)	ASTM 1640	24 hours minimum

1045.7 Liquid Membrane-Forming Compounds for Curing

A. Provide a Type 2 sprayable liquid membrane-forming compound for curing in accordance with ASTM C309. Apply curing compound at the manufacturer's recommended rate of application. In the absence of manufacturer's recommendations, apply until the original color of the concrete is effectively obscured by a uniform white appearance.

SECTION 1046 — CONCRETE OVERLAY MATERIALS

1046.1 Latex Modified Concrete.

1046.1.1 Materials.

A. Portland Cement — Section 1020.

B. fine aggregates — Section 1003 and 1022.

C. coarse aggregate — Section 1022.

1. coarse aggregate grading, Delaware No. 8 — Section 1004.

D. Provide water — Section 1021.

E. Provide a latex modifier for concrete that is a 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.

1046.1.2 Mix Design.

A. Submit the materials for the project to the engineer for approval 40 calendars days before placement.

B. Once materials are approved, submit a mix design using the absolute volume method (ACI Publication 211.1) to the engineer to meet limits shown in Table 1046.1-1.

Mix design submission must include:

1. Source of materials,
2. Proportions of mix components,
3. Laboratory test data from trial batches,
4. Sample of materials used, and
5. Test results of the proposed aggregates for ASR reactivity from a certified lab.
   a. When aggregates are ASR reactive, provide test results of the proposed concrete mixture components and mitigation steps in accordance with Section 1022.3.2.B.
6. Test results from AASHTO 277 showing chloride permeability no greater than 1,000-coulombs based on a 28-calendar-day cure.

Table 1046.1-1. Mix Design Requirements

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

Property	Latex Modified Concrete Mix
Air Content - Maximum Percent of Plastic Mix	6.5%
** Slump (inches)	4 - 6
Water - Cement Ratio	0.40 Max.
Minimum Compressive Strength @ 28 calendar days	4,000 PSI
*The dry weight ratios are approximate and should produce a workable mix 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.	
**Measure the slump 4 to 5 minutes after discharge from the mixer. Do not disturb the mix during this waiting period.	

C. Do not change mix design during construction. Submit any changes to the engineer for approval before continuing the work.

1046.1.3 Acceptance Testing.

A. Field testing will be performed according to Section 1022.

B. Permeability will be verified using 3, 4-inch x 8-inch cylindrical test samples cast in the field and tested according to AASHTO T277 at 28 calendar days.

1046.2 Polyester Polymer Concrete Overlay.

1046.2.1 Materials.

A. Provide High Molecular Weight Methacrylate Primer Section 1045.4

B. Fine Aggregate / Finishing Sand.

1. Natural sand is required for fine aggregate.
2. Dry 8/20 commercial quality blast sand is required for finishing sand.

C. Aggregate requirements:

1. Aggregate retained on the No. 8 sieve must have a maximum of 45 percent crushed particles when tested in accordance with AASHTO Test Method T335.
2. Aggregate absorption must not exceed 1 percent as determined by AASHTO Test Methods T84 and T85.
3. Aggregate must have a minimum Mohs Hardness of 7.
4. Gradation.

Table 1046.2-1. Polyester Polymer Concrete Overlay Gradation

Sieve Size	Percent Passing
3/8”	100
No. 4	62 – 85
No. 8	45 – 67

No. 16	29 – 50
No. 30	16 – 36
No. 50	5 – 20
No. 100	0 – 7
No. 200	0 – 3

D. Polyester Resin Binder

1. Provide an unsaturated isophthalic polyester-styrene co-polymer that contains a minimum 1 percent by weight gammamethacryloxypropyltrimethoxysilane. The promoter must be compatible with methyl ethyl ketone peroxide (MEKP) and cumene hydroperoxide (CHP) initiators. The binder must also meet the following requirements:

Table 1046.2-2. Polyester Resin Binder Requirements

Property	Test Method	Requirement (specimens cured or aged at 77°F unless otherwise specified)
Viscosity[1] (RVT No. 1 Spindle, 20 RPM at 77º F)	ASTM D2196	75 – 200 cps
Specific Gravity[1]	ASTM D1475	1.05 to 1.10 at 77ºF
Elongation	ASTM D638	(Sample conditioned per ASTM D618: 18/25/50 + 5/70) 35 percent minimum Type I at 0.45”/min. Thickness = 1/4” ± 0.04”
Tensile Strength	ASTM D638	(Sample conditioned per ASTM D618: 18/25/50 + 5/70) 17.5 MPa minimum Type I at 0.45”/min. Thickness = 1/4” ± 0.04”
Styrene Content[1]	ASTM D2369	40 percent to 50 percent (by weight)
Silane Coupler	NMR Spectrum	1.0 percent, minimum (by weight of polyester styrene resin)
PCC Saturated Surface Dry Bond Strength	California Test CT551 Part 5	500 PSI minimum at 24 hours and 70±1º F

[1]Tested prior to addition of initiator.

1046.2.2 Mix Design.

A. Submit materials for all components of the overlay system for approval 60 calendar days before placement.

B. Polyester resin content must be 12% ± 1% of the dry aggregate weight.

Submission must include:

1. Source of materials

2. Proportions of mix components
3. Laboratory test data from trial batches
4. Manufacturer's certification of conformance to specifications for
   a. Primer
   b. Aggregate
   c. Polyester Resin

   The engineer reserves the right to require material samples.
5. Applicable MSDSs
6. Manufacturer installation instructions

1046.2.3 Shipping and Storage of Materials.

A. Ship material in strong, substantial containers marked with
   1. Manufacture Date
   2. Batch number
   3. Brand name
   4. Quantity Shipped
   5. Expiration date / shelf life
   6. Mixing ratio of the component

B. Notify the engineer of bulk resin shipment containers that exceed 55 gallons 10 calendar days prior to delivery.

C. Store materials in accordance to manufacturer's recommendations. Conform to applicable fire codes and safety regulations.

D. Store aggregates in accordance with Section 1022.11.

1046.2.4 Production Requirements.

A. Follow manufacturer production and installation requirements

B. At mixing time, aggregate moisture content may not exceed 1/2 of the aggregate absorption as determined by AASHTO T255.

1046.2.5 Acceptance

A. Overlay must have a minimum bond strength of 250 PSI per ACI 503R-93, Appendix A.

B. Verify surface does not contain:
   1. Depressions in the surface that will pond water.
   2. Deviations in excess of 1/4-inch in 10-feet in any direction.
   3. Areas lacking surface texture.

1046.3 Modified Class D Portland Cement Concrete Overlay.

1046.3.1 Materials.

A. Provide Class D PCC in accordance with Section 1022 with the following modifications

1. Provide a coarse aggregate gradation conforming to the requirements of Section 1004, Delaware #8.
2. Provide a mix design including a shrinkage reducing / compensating admixture. Provide an admixture dosage as recommended by the manufacturer. Provide an admixture that:
   a. Consists of 1 product or 2 separate products that provide both concrete expansion and reduction of concrete pore water surface tension.
   b. Expands at a rate that closely compensates for the shrinkage of the concrete mix.
   c. Provide 80 percent or greater shrinkage reduction as measured and documented by field performance.
   d. Is formulated for use in freeze/thaw weather.
   e. Contains 0.1 percent or less chloride by weight.

B. Provide a latex bonding agent that conforms to ASTM C1059 Type II.

C. Provide an epoxy bonding agent that conforms to AASHTO M235 Type V.

D. Provide a silane sealer in accordance with Section 1045.

1046.3.2 Production Requirement.

A. Utilize a DelDOT approved Concrete Supplier to deliver Class D Modified concrete to the site.

1046.3.3 Acceptance.

A. Overlay must have a minimum bond strength of 250 PSI per ACI 503R-93, Appendix A.

B. Minimum 28-day Compressive Strength - 4,500 pounds per square inch

C. Verify surface does not contain:

1. Depressions in the surface that will pond water.
2. Deviations in excess of 1/4-inch in 10’ in any direction.
3. Areas lacking surface texture.

D. Field testing will be performed according to Section 1022.

E. Permeability will be verified using 3, 4 -inch x 8-inch cylindrical test samples cast in the field and tested according to AASHTO T277 at 28 -calendar days.

SECTION 1047 — GROUT AND FLOWABLE FILL

1047.1 Flowable Fill.

1047.1.1 Materials.

A. Provide Portland cement conforming to Section 1020.

B. Provide fine aggregates in accordance with Section 1022.

C. Provide Air Entraining Admixtures conforming to AASHTO M154.

D. Provide Chemical admixtures conforming to AASHTO M194.

E. Provide Fly Ash conforming to Section 1020.

F. Provide Ground Granulated Blast Furnace Slag (GGBFS) conforming to Section 1020.

G. Provide water conforming to the requirements of Section 1021.

1047.1.2 Mix Design.

A. Submit the proposed fly ash material test data to the engineer 40 calendar days before 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.

B. Once the fly ash is approved, submit a mix design to the engineer.

1. 28-day compressive strength requirement is 50 to 200 PSI or as required by the contract.

1047.1.3 Production and Acceptance.

A. Produce flowable fill in batching plants meeting the requirements of Section 1022.6.2.

B. Test compressive strength in accordance with procedures in AASHTO T106M/T.

1047.2 Non-Shrink Grout.

A. Provide grout for general purpose use meeting ASTM C1107 Grade C.

1047.3 Access Tubes.

A. Use a neat cement grout with a minimum water/cement ratio of 0.45 for filling the access tubes at the completion of the crosshole sonic log tests. Provide grout with a minimum compressive strength that matches or exceeds the specified minimum design compressive strength of the drilled shaft as noted in the contract.

1047.4 Epoxy Grout.

A. Provide rapid strength gain epoxy grout systems that are 100 percent solids, containing thermosetting epoxy resin, expansive additives, and fine aggregate and match or exceed the test values in Table 1047.4-1.

Table 1047.4-1. Epoxy Grout Test Values

Properties	Test Values	Test Method
Compressive Strength	8,000 PSI @ 2 days	ASTM C579, Method B

	12,000 PSI @ 28 days	
Tensile Strength	2,000 PSI @ 7 days	ASTM C307
Bond Strength	3,500 PSI @ 7 days	ASTM C882

1047.5 Chemical Sealing.

A. Provide chemical sealing (grouting) materials in accordance with the NASSCO specification, Chemical Sealing (Grouting) Materials. Submit the materials and mix to the engineer for approval. Mix, handle, and apply all materials in accordance with the manufacturer's recommendations.

1047.6 Mortar.

1047.6.1 Materials.

A. Provide fine aggregate conforming to Section 1003.

B. Provide water conforming to Section 1021.

C. Provide Portland cement conforming to 1020.

1047.6.2 Mix Design.

A. Mix mortar in the proportion of one-part Portland cement to 3 parts fine aggregate and add hydrated lime not to exceed 10 percent of the cement by weight. Mix the fine aggregate, Portland cement, and lime until the mixture assumes a uniform color. Add water as needed while the mixing continues until the mortar attains an easily spreadable consistency.

SECTION 1048 — MECHANICALLY STABILIZED EARTH WALL MATERIALS

1048.1 Material Requirements.

A. Provide backfill in accordance with the following:

1. Free from organic and deleterious materials.
2. Do not use metallurgical slag.
3. Number 57 stone in accordance with Section 1004.
4. Soil meeting the following requirements:
   a. Magnesium sulfate soundness loss less than 30 percent after 4 cycles determined by AASHTO T104.
   b. Plasticity index (P.I.) less than 6 as determined by AASHTO T90.
   c. Fraction finer than 15-microns less than 10 percent as determined by AASHTO T88.
   d. Angle of internal friction 34-degrees or greater determined by the standard direct shear test in accordance with AASHTO T236. The shear test must include material finer than the #10 sieve and compacted to 95 percent of AASHTO T99, Method C or D (with oversize correction, as outlined in note 7, AASHTO T99) at optimum moisture content.
   e. Electrochemical properties in accordance with the following:

Table 1048.1-1. Electrochemical Soil Properties

Property	Value
pH	5 to 10
Resistivity (min)*	3,000 ohm-cm
Chloride Content (Max)	100 ppm
Sulphate Content (Max)	200 ppm
Organic Content (Max)	1%

*If the resistivity is greater than 5,000 ohm-cm, the engineer may waive the chloride and sulfate requirements.

   f. Gradation requirements in accordance with AASHTO T27 as outlined below:

Table 1048.1-2. Soil Gradation Requirements

Sieve Size	Percent Passing
3 inches (75 mm)	100%
3/4-inch (18 mm)	20% to 100%

No. 40 (425 µm)	0% to 60%
No. 200 (75 µm)	0% to 10%

g. The engineer will direct the frequency of sampling of select granular backfill necessary to assure gradation control throughout construction.

B. Provide concrete in accordance with Sections 610, 612, and 1022. Unless noted otherwise, provide concrete meeting the following:

1. Leveling pad – Class B, 3,000 PSI.
2. Wall panels – Class A, 4500 PSI.
3. Coping – Class A, 4500 PSI.

C. Provide reinforcing mesh in accordance with ASTM A1064. Provide galvanization for the mesh in accordance with AASHTO M111.

D. Provide bar reinforcement in accordance with Sections 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 AASHTO M111 or M232.

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 in the horizontal joints between facing panels with a minimum density of 0.946 g/cm3 in accordance with ASTM D1505.

H. If alignment pins are used, provide pins that are 5/8-inch minimum diameter, mild steel, round, smooth, and galvanized to meet the requirements of AASHTO M111.

I. Provide tie strip that is shop fabricated of hot rolled steel in accordance with ASTM A1011, Grade 50. Provide galvanization in accordance with AASHTO M111.

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 AASHTO M111.

K. In lieu of metallic reinforcement, provide structural geostrips made of high-tenacity polyester fibers with linear low-density polyethylene coating. Provide geostrips that have a high resistance to deformation under sustained long-term design load. Provide geostrips resistant to ultraviolet degradation, damage under normal installation practices, and all forms of biological and/or chemical degradation.

L. Provide mechanically galvanized bolts and nuts in accordance with Section 1039.

M. Provide mortar in accordance with Section 1047.6 to fill recesses at lifting devices.

N. Provide cast-in-place concrete in accordance with Sections 610 and 1022. Unless noted otherwise, provide concrete meeting the following:

1. Leveling pad – Class B, 3,000-PSI.
2. Coping – Class A, 4500-PSI.
3. Liquid membrane-forming compounds for curing in accordance with Section 1045.7.

O. Provide precast concrete wall panels in accordance with the following:

1. Casting.
   a. 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.
   b. Set rebar and lifting devices in place to the dimensions and tolerances shown on the contract before casting.
   c. Place the concrete in each unit without interruption and consolidate using an approved vibrator, supplemented by hand tamping as necessary to force the concrete into the corners of the forms and prevent the formation of aggregate pockets, air bubbles, or cleavage planes.
   d. Use clear form oil of the same manufacturer throughout the casting operation.
2. Concrete finish:
   a. Front - In accordance with the contract.
   b. Rear - Unformed surface, float finish to eliminate open pockets of aggregate and surface distortions in excess of 1/8-inch.
   c. Marking - Clearly scribe on the rear face of each panel the date of manufacture, the production lot number, and the piece-mark.
3. Curing - Cure the units for at least 72-hours. The engineer will reject any panel that does not reach specified strength within 28-calendar days.
4. Removal of forms - Do not remove the forms until removal does not cause damage to the unit.
5. Acceptance
   a. Tolerances:
      i. Panel dimensions - Within 3/16-inch except that the lateral position of tie strips within 1 inch.
      ii. Panel squareness - Within 1/2-inch as determined by the difference between the 2 diagonals.
      iii. Panel surface defects:
      (1) Smooth formed surfaces - Not to exceed 1/8-inch per 5-foot length.
      (2) Textured finished surfaces - Not to exceed 5/16-inch per 5-foot length.
   b. Provide compression testing for precast units that indicates strength will meet the 28-day specifications.
      i. Panels using Type I or II cement become acceptable for placement in the wall when 7-day strengths exceed 80-percent of the 28-day requirements.
      ii. Panels utilizing Type III cement become acceptable for placement in the wall when compressive strength test results indicate that the strength meets the 28-day requirements.

c. Provide units that exhibit none of the following:

i. Defects that indicate imperfect molding.

ii. Defects that indicate honeycombed or open texture concrete.

iii. Defects in the physical characteristics of the concrete, such as broken or chipped concrete.

iv. Stained form face, due to excessive form oil or others.

v. Signs of aggregate segregation.

vi. Broken or cracked corners.

vii. Bent or damaged tie strips.

viii. Damaged or unstable lifting inserts.

ix. Exposed reinforcing steel.

x. Cracks at the PVC pipe or pin.

xi. Thickness varying in excess of + 3/16-inch from that shown on the contract.

6. Handling, Storage and Shipping – Handle, store, and ship the panels in a manner that will 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.

P. 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

1049.1 Pipe for Weep Holes.

A. Plastic pipe for weep holes in conformance with ASTM D2665.

1049.2 Form Oil for Concrete Formwork.

A. Use form oil that is a non-staining petroleum distillate free from water, asphaltic, and other insoluble residue.

1049.3 Waterstops.

A. 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.

B. No reclaimed PVC from any sources are permitted for incorporation into the compounding.

C. 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

1060.1 Materials.

A. Provide geotextiles from the Approved Products List (https://deldot.gov/Business/)

Table 1060.1-1. Geotextile Material Requirements

Item Name	Under Riprap Geotextile Lined Channel Diversion MSE Wall Stabilized Construction Entrance Stabilization (within roadway) Separation (within roadway)	Silt Fence Reinforced Silt Fence Super Silt Fence
Minimum Grab Tensile Strength [lbs] (ASTM D-4632)	300	100
Maximum Grab Tensile Elongation [%] (ASTM D-4632)	15	20
Minimum Trapezoidal Tear Strength [lbs] (ASTM D-4533)	100	50
Minimum Puncture Strength [lbs] (ASTM D-4833)	150	60
Apparent Opening Size [US sieve] (ASTM D-4751)	40-80	30-80
Minimum UV Resistance after 500 hours [%] (ASTM D-4355)	70	70
Maximum Flow-thru Rate [gpm/sf] (ASTM D-4491)	6	10

Item Name	Drainage Inlet Sediment Control Sump Pit Portable Sediment Tank	Curb Inlet Sediment Control	Dewatering Bag	Underdrain Infiltration Trench Lining (non-woven)
Minimum Grab Tensile Strength [lbs] (ASTM D-4632)	200	265	200	100
Maximum Grab Tensile Elongation [%] (ASTM D-4632)	40	40	50	50

Minimum Trapezoidal Tear Strength [lbs] (ASTM D-4533)	50	50	80	45
Mullen Minimum Burst Strength [PSI] (ASTM D-3796)	NA	NA	350	NA
Minimum Puncture Strength [lbs] (ASTM D-4833)	45	100	130	NA
Apparent Opening Size [US sieve] (ASTM D-4751)	30-80	20-40	40-80	70-80
Minimum UV Resistance after 500 hours [%] (ASTM D-4355)	70	70	70	70
Minimum Flow-thru Rate [gpm/sf] (ASTM D-4491)	110	110	70	110

SECTION 1061 — FENCE

1061.1 Markings.

A. Provide fence fabric carrying a tag showing:

1. Base metal type (steel or aluminum alloy number),
2. Coating type and class,
3. Wire diameter,
4. Length of fencing in the roll, and
5. Name or mark of the manufacturer.

B. Identify posts, wire, and other fittings by:

1. Manufacturer,
2. Base material type (steel or aluminum alloy number),
3. Class or coating, and
4. Pertinent data for proper identification and verification of conformance to the requirements herein.

1061.2 Inspection.

A. Each product or item provided remains subject to inspection at the factory and the fabricating plant, in laboratories of the Department's choosing, and at all other points of delivery.

1061.3 Chain Link Fence.

A. Chain-link fabric made of 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 M181.

B. Terminal, corner, and gate posts – AASHTO M181, Type I or Type II, Grade 1 or 2. Provide consistent coating type within a single fence installation.

C. Line posts – AASHTO M181, Type I or Type II, Grade 1 or 2. Provide consistent coating type within a single fence installation.

D. Top rail – AASHTO M181, Type I or Type II, Grade 1 or 2. Provide consistent coating type within a single fence installation.

E. Outriggers – AASHTO M181.

F. Barbed wire – Use galvanized steel for barbed wire conforming to the requirements of AASHTO M280 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 5-inch intervals or less. Use AASHTO M280 Type Z, Class 3 for galvanizing.

G. Tension wire – AASHTO M181, Type 1, Class 1.

H. Brace band for tension wire – AASHTO M181.

I. Stretcher bar – AASHTO M181.

J. Stretcher bar bands – AASHTO M181.

K. #6-gauge fabric ties – AASHTO M181, Type 1 class D coated.

L. #9-gauge fabric ties – AASHTO M181, Type 1 class D coated.

M. Hog ring fasteners – AASHTO M181, Type 1 class D coated.

N. Truss rod assembly – AASHTO M181.

O. Galvanized steel anchor blades – AASHTO M270, Grade 36, galvanized in accordance with AASHTO M111.

P. Galvanized carriage bolts and elastic stop nuts – AASHTO M181.

Q. Anchor shoes – AASHTO M181.

R. Ground rod:

1. Underwriters Laboratories Listed and Approved.
2. 5/8-inch Nominal Diameter.
3. 8 feet long, Minimum.
4. Copper-bonded Steel.

S. Ground rod clamp:

1. Underwriters Laboratories UL467 Approved.
2. No. 6 solid copper conductor.

T. Vinyl coating:

1. When required by the contract, vinyl coat all chain link fence materials in accordance with AASHTO M181 Type IV Class A.

1061.4 Right-of-Way Fence.

A. Tubular end post – AASHTO M181, Type I or Type II, Grade 1 or 2. Provide consistent coating type within a single fence installation.

B. Tubular terminal post – AASHTO M181, Type I or Type II, Grade 1 or 2. Provide consistent coating type within a single fence installation.

C. Woven wire fencing – Provide woven wire fencing or woven wire fabric made of #9-gage galvanized wire conforming to the requirements of AASHTO M279, Grade 60, Type Z, Class 3 coating.

D. One strand barbed wire – Use galvanized steel for barbed wire conforming to the requirements of AASHTO M280 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 5-inch intervals or less. Use AASHTO M280, Type Z, Class 3 for galvanizing.

E. Diagonal brace – AASHTO M181, Type I or Type II, Grade 1 or 2. Provide consistent coating type within a single fence installation.

F. Line post with anchor plate – In accordance with AASHTO M281 that are either galvanized in accordance with AASHTO M111, painted with resistant paint that is specifically designed for steel, or painted with shop or factory-based enamel.

G. Terminal and end post clamps or #9-gage wire ties – AASHTO M181.

H. Line post clamps or wire ties – AASHTO M281.

I. Terminal and end post caps – AASHTO M181.

J. Ground rod:

1. Underwriters Laboratories Listed and Approved.
2. 5/8-inch Nominal Diameter.
3. 8 feet long, Minimum.
4. Copper-bonded Steel.

K. Ground rod clamp:

1. Underwriters Laboratories UL467 Approved.
2. No. 6 solid copper conductor.

1061.5 Wood Post and Rail Fence.

A. Rails - Grade 1 lumber in accordance with AASHTO M168. Treat lumber in accordance with Section 1041.4.A.4 with waterborne preservative.

B. Posts - Grade 1 lumber in accordance with AASHTO M168. Treat lumber in accordance with Section 1041.4.A.4 with waterborne preservative.

C. Hardware - conforming to Section 1041.5.D.

1061.6 Vinyl Post and Rail Fence.

A. Posts:

1. Made of high impact, ultraviolet (UV) resistant, rigid poly vinyl chloride (PVC), complying with ASTM D1784, Class 14244-B, Table 1.
2. Use posts with a minimum wall thickness of 0.135 inches and a minimum corner radius of 3/8 inches.

B. Rails:

1. Made of high impact, ultraviolet (UV) resistant, rigid poly vinyl chloride (PVC), complying with ASTM D1784, Class 14244-B, Table 1.
2. Use rails with a wall thickness of 0.90 inches and a minimum corner radius of 11/32 inches.

C. Post caps:

1. Made of high impact, ultraviolet (UV) resistant, rigid poly vinyl chloride (PVC), complying with ASTM D1784, Class 14244-B, Table 1.
2. Provide 1 piece molded caps with a minimum thickness of 0.095 inches that match the pole cross section.

D. Fasteners – provide fasteners in accordance with manufacturer recommendations.

E. Anchorages – provide anchorages in accordance with manufacturer recommendations.

F. PVC cement – provide PVC cement in accordance with manufacturer recommendations.

G. Other hardware - provide other incidentals meeting the requirements of the manufacturer.

1061.7 Wood Vertical Slat Fence.

A. Vertical boards – Southern yellow pine, grade 2 lumber or better in accordance with AASHTO M168. Pressure treat in accordance with Section 1041.4.

B. Posts – Southern yellow pine, grade 2 lumber or better in accordance with AASHTO M168. Pressure treat in accordance with Section 1041.4.

C. Backers - Southern yellow pine, grade 2 lumber or better in accordance with AASHTO M168. Pressure treat lumber in accordance with Section 1041.4.

D. Hardware - Provide hardware in accordance with Section 1041.5.D.

1061.8 Decorative Fence.

A. Materials:

1. Posts - Use posts in the fence system that meet 6105T5 in accordance with ASTM B221, or an aluminum alloy having a minimum strength of 35,000-PSI.
2. Rails - Use rails in the fence system that meet 6105T5 in accordance with ASTM B221, or an aluminum alloy having a minimum strength of 35,000-PSI.
3. Pickets - Use pickets in the fence system that meet 6105T5 in accordance with ASTM B221, or an aluminum alloy having a minimum strength of 15,000-PSI.
4. Fasteners – Use 302 stainless-steel self-drilling head for all screws. Paint all screws to match the finish of fence. Provide fasteners compatible with fence material for exterior exposure.
5. Post caps - aluminum castings in accordance with ASTM B26.
6. Brackets - aluminum castings. If any material will come into contact with PCC, use galvanized steel for castings.
7. Scrolls - aluminum castings. If any material will come into contact with PCC, use galvanized steel for castings.
8. Finishes - aluminum castings. If any material will come into contact with PCC, use galvanized steel for castings.
9. Other miscellaneous hardware - aluminum castings. If any material will come into contact with PCC, use galvanized steel for castings.
10. Non-shrink grout – Use a non-shrink grout to fill post sleeves.
11. Provide grout with a minimum compressive strength of 5,000-PSI and 0 expansion or shrinkage at 7-calendar days when tested in accordance with AASHTO T106 and AASHTO T160, respectively.

B. Pretreatment.

1. Apply a 3-stage non-chrome pretreatment as follows:
   a. Chemically clean,
   b. rinse with water, and then
   c. apply a dry-in-place activator that produces a uniform chemical conversion coating.
2. Plate the screws in accordance with the manufacturer's recommendations.

C. Coating - Provide material coated in accordance with manufacturer's recommendations. Do not use epoxy powder coatings, baked enamel, or acrylic paint finishes. Finish materials with a cured film thickness of 50-µm or greater. Paint the screw heads to match the color of the fence.

1. Tests – Provide a cured approved finish meeting the following requirements:
   a. Humidity resistance of 3,000-hours using ASTM D2247.
   b. Salt spray resistance of 3,000-hours using ASTM B117.
   c. Accelerated weathering for 1,000-hours under ASTM D822 showing no adhesion loss, with only a slight fading, chalking, and water staining.
   d. Minimum hardness of 2H using ASTM D3363.

D. Grounding material:

1. Ground rod:
   a. Underwriters Laboratories Listed and Approved.
   b. 5/8-inch Nominal Diameter.
   c. 8 feet long, Minimum.
   d. Copper-bonded Steel.
2. Ground rod clamp:
   a. Underwriters Laboratories UL467 Approved.
   b. No. 6 solid copper conductor.

1061.9 Temporary Construction Safety Fence.

A. Fencing:
   1. U.V. stabilized high visibility orange, high density polyethylene.
   2. Standard mesh opening size of approximately 1 1/2-inches.

B. Post:
   1. Hardwood stake.
   2. T-section steel 1.25-inches x 1.00-inch.

1061.10 Bridge Safety Fence.

A. Chain-link fabric made of galvanized steel fabric fence, #9-gage having a 1-inch diamond mesh unless specified otherwise. Type 1 class D coated, knuckled top and bottom or twist top/knuckle

bottom conforming to the appropriate requirements of AASHTO M181. Ensure fabric is continuous across all joints.

B. Vertical post – Made of steel pipe in accordance with the requirements of AASHTO M181, Type I or Type II, Grade 1 or Grade 2, schedule 40 with a minimum strength of 50,000-PSI. Provide consistent coating type within a single fence installation.

C. Longitudinal pipe – Made of steel pipe in accordance with the requirements of AASHTO M181, Type I or Type II, Grade 1 or Grade 2, schedule 40 with a minimum strength of 50,000-PSI. Provide consistent coating type within a single fence installation.

D. Base plate - Provide base plates of a minimum steel grade of 36,000-PSI galvanized in accordance with ASTM A123.

E. Anchor studs - ASTM A276.

F. Hex nuts and washers for anchor studs – AASHTO M181.

G. Single #9-gage or double #13-gage tie wires - AASHTO M181, Type 1 class D coated.

H. Stretcher bar attachment – AASHTO M181.

I. Stretcher bar – AASHTO M181.

J. Truss rod assembly – AASHTO M181.

K. Brace band and fitting – AASHTO M181.

L. Carriage bolt and nut- AASHTO M181.

M. Cap – AASHTO M181.

N. Vinyl coating:

1. When required by the contract, vinyl coat all chain link fence materials in accordance with AASHTO M181 Type IV Class A.

1061.11 Chain Link Fence Gate.

A. Gate frame:

1. Conforming to the requirements of AASHTO M181.

2. Provide corners made of heavy malleable iron or pressed steel fittings, securely riveted or welded.

3. Paint the welds with aluminum base or zinc base paint.

B. Chain-link fabric made of 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 M181.

C. Upper hinge – AASAHTO M181.

D. Lower hinge – AASAHTO M181.

E. Stretcher bar – AASAHTO M181.

F. Stretcher bar band – AASAHTO M181.

G. Locking device – AASAHTO M181.

H. Vinyl coating:

1. When required by the contract, vinyl coat all chain link fence materials in accordance with AASHTO M181 Type IV Class A.

1061.12 Right-of-Way Fence Gate.

A. Gate frame:

1. Conforming to the requirements of AASHTO M181.
2. Provide corners made of heavy malleable iron or pressed steel fittings, securely riveted or welded.
3. Paint the welds with aluminum base or zinc base paint.

B. Woven wire fencing - Provide woven wire fencing or woven wire fabric made of #9-gage galvanized wire conforming to the requirements of AASHTO M279, Grade 60, Type Z, Class 3 coating.

C. Upper hinge – AASHTO M181.

D. Lower hinge – AASHTO M181.

E. Stretcher bar – AASHTO M181.

F. Stretcher bar band – AASHTO M181.

G. Locking device – AASHTO M181.

SECTION 1062 — CONDUIT

1062.1 Material Requirements.

Provide conduit, sweeps, end caps, conduit bodies, conduit hangers, bushings, and all applicable appurtenances of compatible materials in accordance with the contract and these requirements.

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 NEC 2011, Article 344.
4. UL listed.

B. HDPE SDR 13.5 Conduit:

1. Conform to NEC 2017, 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 NEC 2017, Article 352.
3. Conform to ASTM D1785.
4. Conform to U.L. Standard 651 specifications for conduit.
5. Conform to U.L. Standard 614b specifications for fittings.
6. For fiber optic conduit, paint in white letters longitudinally, “DelDOT traffic fiber optic cable.”
7. For lighting conduit, paint in white letters longitudinally, “DelDOT lighting cable.”
8. For traffic signal conduit, paint in white letters longitudinally, “DelDOT traffic signal cable.”
9. UL listed.

D. Flexible Metallic Liquid Tight Conduit:

1. Conform to the NEC 2017, 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 NEC 2017, 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 percent 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

1070.1 Materials.

Provide materials for guardrail, rub rail, structural steel posts, and related hardware in accordance with the contract and these requirements:

A. Steel Posts, Steel Offset Blocks, and Steel Shapes - ASTM A769 and hot-dipped galvanized per AASHTO M111.

B. Beams - AASHTO M180, Class A, except where specified as Class B Type I or Type II and hot-dipped galvanized per AASHTO M111.

C. Hardware - AASHTO M180 and zinc coated per AASHTO M232.

D. Rods and Turnbuckles - Minimum tensile strength of 60,000 pounds and hot-dipped galvanized per AASHTO M111.

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 M111 before swaging. Anneal suitably for cold swaging. Mill into the stud end a 3/8-inch slot for the locking pin before 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 M30 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 A6 and galvanized to AASHTO M232. Retroreflective sheeting per ASTM D4956, Type IV abrasive resistant.

H. Timber Post, Blocks, and Offset Blocks - Dimensions per the Standard Construction Details.

1. Composite offset blocks in accordance with DelDOT's Approved Product List.

2. Timber used for post, blocks, and offset blocks per Section 621 and the preservative treatment per Section 1041.4.A.5.

   a. Only use timber offset blocks when explicitly required by the Standard Construction Details or manufacturer's installation requirements.

SECTION 1071 — PAVEMENT MARKINGS

1071.1 Latex Pavement Markings.

A. Provide latex paint meeting the requirements of 1071.1.1 and glass beads meeting the requirements of 1071.1.2 that when combined, meet the retroreflectivity requirements of 1071.1.3.

1071.1.1 Latex Paint.

A. Provide a ready-mixed emulsified pigmented binder which is capable of anchoring glass beads.

B. The latex paint is to meet the following physical and composition requirements:

1. Pigment.

   a. The pigment portion is to be a combination of pigments as required to produce a finished product color matching Federal Test Standard No. 595A, Latest Edition, No. 33538 for Yellow and No. 37886 for White.

   b. For white paint, use rutile type titanium dioxide conforming to ASTM D476 at a minimum rate of 1 pound per gallon as the prime pigment.

   c. For yellow paint, use a non-toxic organic yellow pigment and rutile type titanium dioxide conforming to ASTM D476 at a minimum rate of 0.2 pounds per gallon.

   d. Percent pigment by weight of the finished product is not to be less than 60 percent and not more than 62 percent.

2. Vehicle.

   a. Use a non-volatile vehicle that is not less than 42 percent by weight.

3. Organic Volatiles.

   a. The volatile organic content (VOC) of the finished paint is to contain less than 1.25 pounds per gallon of volatile organic matter of total Non-volatile paint material.

4. Volume of Solids.

   a. The finished paint will not be less than 61 percent solids by volume, when tested in accordance with ASTM D2369.

5. Total Solids.

   a. The finished paint is not to be less than 77.5 percent total non-volatiles by weight, when tested in accordance with ASTM D2369.

6. Grind.

   a. Not less than 2 Hegman when tested in accordance with ASTM D1210.

   7. Laboratory Drying Time.

   a. Not more than 10-minutes when tested in accordance with ASTM D711.

8. Viscosity. Not less than 70 nor more than 95 KREB units at 77 degrees F, when tested in accordance with ASTM D562.

9. Flexibility. Show no cracking or flaking when tested in accordance with Federal Specification TT-P 1952F.
10. Dry Opacity. The minimum contrast ratio is to be 0.95 when tested in accordance with ASTM D2805 at a wet film thickness of 5-mils.
11. Abrasion Resistance. The abrasion resistance is to be such that no less than 210-liters of sand will be required for removal of the paint film when tested in accordance this Federal Specification TT-P-1952F.
12. Freeze-Thaw Stability. Show no coagulation or change in consistency greater than 5 KREB units, when tested in accordance with Federal Specification TT-P-1952F.
13. Dilution Test. Be capable of dilution with water at all levels without curdling or precipitation such that the wet paint can be readily cleaned up with only water.
14. Dry Through (Early Washout). The dry through time of a 15-mil wet film placed immediately in a Humidity Chamber, maintained at 72.5 plus or minus 2.5 degrees F and 90 plus or minus 5 percent relative humidity will not be less than or equal to the Department Laboratory reference film when tested in accordance with ASTM D1640, except that the pressure exerted the minimum needed to maintain contact with the thumb and film.
15. Bleeding. Have a minimum bleeding ratio of 0.98 when tested in accordance with the method given in Federal Specification TT-P-1952F. The asphalt-saturated felt is to conform to FS HH-R-590.

1071.1.2 Glass Beads.

A. Provide AASHTO M247 Type 1 glass beads with the following additional properties:

1. Have moisture resistant coating which passes AASHTO T346 Moisture Resistant Coating Test,
2. Are a minimum of 80 percent true spheres when tested in accordance with ASTM D1155, and
3. Flow freely from dispensing equipment.

1071.1.3 Retroreflectivity.

A. Obtain the following minimum reflectivity values when tested with a Retroreflectometer with 30-meter geometry, or Department approved equal:

1. 150 millicandellas for white lines.
2. 125 millicandellas for yellow lines.

1071.2 Epoxy Pavement Markings.

A. Provide epoxy paint meeting the requirements of 1071.2.1 and glass beads meeting the requirements of 1071.2.2 and 1071.2.3 that when combined, meet the retroreflectivity requirements of 1071.2.6. Provide black contrast markings meeting 1071.2.4 and black aggregate meeting 1071.2.5 when required by the contract.

1071.2.1 Epoxy Paint.

A. Composition Requirements.

1. Use an epoxy resin composition specifically formulated for use as a hot-spray application at elevated temperatures.

2. Comprised of a 2-component (part A and part B), 100 percent solids type system formulated and designed to provide a simple volumetric mixing ratio.

3. Component A.

a. Conform to the requirements of Table 1071.2-1.

Table 1071.2-1. Component A Requirements, % by Weight

	White	Yellow
Pigments	Titanium Dioxide - 18% Min. (rutile type conforming to ASTM D476)	Organic Yellow - 6%-10% Titanium Dioxide – 10% min. (rutile type conforming to ASTM D476)
Epoxy	75% Min., 82% Max.	70% Min., 80% Max.

b. Component A white shall contain no extender pigments.

c. The epoxy content of the epoxy resin will be tested in accordance with ASTM D1652 and calculated as the weight per epoxy equivalent (WPE). The epoxy content will be determined on a pigment free basis. The epoxy content (WPE) is to be within ± 50 of the target value provided by the manufacturer.

4. Component B.

a. The amine value of the curing agent will be tested in accordance with ASTM D2074 to determine its total amine value. The total amine value is to be within ± 50 of the target value provided by the manufacturer.

B. Physical Properties.

1. Unless specified otherwise, all samples are to be prepared and tested at an ambient temperature of 73 ± 5 degrees F.

2. Toxicity. The material is to not exude fumes which are toxic or injurious to persons or property Upon heating to application temperature.

3. Color.

a. The white epoxy composition when applied at a minimum wet film thickness of 20+1 mils as applicable and allowed to dry, is to plot within the boundaries described by the four corner points listed in Tables 1 and 2 of ASTM D6628 when measured in accordance with the test methods prescribed in Section 7 of ASTM D6628.

b. The yellow epoxy composition when applied at a minimum wet film thickness of 20±1 mils as applicable and allowed to dry, is to plot within the boundaries described by the four corner points listed in Tables 1 and 2 of ASTM D6628 when measured in accordance with the test methods prescribed in Section 7 of ASTM D6628.

4. Directional Reflectance.

a. The white epoxy composition (without glass spheres) is to have a daylight directional reflectance of not less than 84 percent relative to a magnesium oxide standard when tested in accordance with ASTM E1347.

b. The yellow epoxy composition (without glass spheres) is to have a daylight directional reflectance of not less than 55 percent relative to a magnesium oxide standard when tested in accordance with ASTM E1347.

5. Laboratory Drying Time. The epoxy composition is to exhibit a no-track condition in 15-minutes or less when tested in accordance with ASTM D711 and applied with glass beads at the proper saturation.

6. Abrasion Resistance. The wear index of the composition is not to exceed 82 when tested in accordance with ASTM D4060 using a CS-17 wheel and under a load of 1000 grams for 1000 cycles.

7. Tensile Strength. The tensile strength of the epoxy composition is to be 6000 psi or greater when tested in accordance with ASTM D638 using a Type IV specimen. Specimens shall be cured between 24-hours to 96-hours at 75 ± 5 F.

8. Compressive Strength. The compressive strength of the epoxy composition is to be 12,000 psi or greater when tested in accordance with ASTM D695. Test specimens shall be cured 24-hours to 96-hours at 75 ± 5 degrees F.

9. Hardness. The epoxy composition is to have a Shore D hardness between 75 and 100 when tested in accordance with ASTM D2240 after a sample drying period not less than 24-hours nor more than 96-hours prior to testing.

10. Adhesion to Concrete. Have a 100 percent concrete failure and 4000 psi minimum adhesion to the concrete surface when tested in accordance with ACI Method 503.

1071.2.2 Type 1 Glass Beads

A. Provide AASHTO M247 Type 1 glass beads with the following additional properties:

1. Have moisture resistant coating which passes AASHTO T346 Moisture Resistant Coating Test,

2. Are a minimum of 80 percent true spheres when tested in accordance with ASTM D1155,

3. Silica content of the glass sphere is not less than 60 percent,

4. The average crushing resistance of the spheres when tested in accordance with ASTM D1213 will be a 40-pound dead weight, for 20 to 30 mesh spheres.

1071.2.3 Type 4 Glass Beads

A. Provide AASHTO M247 Type 4 glass beads with the following additional properties:

1. Have moisture resistant coating which passes AASHTO T346 Moisture Resistant Coating Test,

2. Are a minimum of 80 percent true spheres when tested in accordance with ASTM D1155,

3. Silica content of the glass sphere is not less than 60 percent,

4. The average crushing resistance of the spheres when tested in accordance with ASTM D1213 will be a 40-pound dead weight, for 20 to 30 mesh spheres.

1071.2.4 Black Contrast Markings

A. Composition Requirements.

1. Use material composed only of epoxy resins and pigments for use as a hot-spray applied binder for black aggregate at elevated temperatures.
2. Comprised of a 2-component (part A and part B), 100 percent solids type system formulated and designed to provide a simple volumetric mixing ratio.
3. Conform to the requirements in Table 1071.2-2.

Table 1071.2-2 Black Contrast Marking Composition Requirements

Component	Percent by Weight
Carbon Black	7±2 percent, by weight
Talc	14±2 percent, by weight
Epoxy Resin	79±4 percent, by weight

1071.2.5 Black Aggregate

A. Provide angular aggregate with no dry dispensement pigment meeting the following physical properties.

B. Gradation. Conform to the requirements (AASHTO T27) in Table 1071.2-3.

Table 1071.2-3 Black Aggregate Gradation Requirements

Sieve Size	Percent Retained
#20	17-37%
#30	45-65%
#40	14-25%

C. Moisture Resistant. Provide a moisture resistant coating.

1071.2.6 Retroreflectivity

A. Obtain the following minimum reflectivity values when tested with a Retroreflectometer with 30-meter geometry, or Department approved equal:

1. 450-millicandellas for white lines.
2. 325-millicandellas for yellow lines.
3. Any single reading may not be less than 350-millicandellas for white and 250-millicandellas for yellow.

1071.3 Alkyd Type Thermoplastic Pavement Markings

A. Provide alkyd type thermoplastic striping material meeting the requirements of 1071.3.1 and glass beads meeting the requirements of 1071.3.2 that when combined, meet the retroreflectivity requirements of 1071.3.3.

1071.3.1 Alkyd Type Thermoplastic Striping Material.

A. General.

1. Provide thermoplastic striping material meeting the requirements of AASHTO M249 that is capable of fusing itself to asphalt, concrete pavement, high friction surface treatments, or previous thermoplastic markings.
2. Material must not deteriorate or discolor when reheated.

B. Environmental Conditions.

1. Does not deteriorate upon contact with sodium chloride, calcium chloride, or other de-icing chemicals or because of oil content of paving materials or oil drippings.
2. Does not permanently discolor or soften by contact with hot-mix bituminous concrete.

C. Bond Strength. Bond strength to pavement greater than 180 psi when tested in accordance with ASTM D4796.

D. Alkyd Binder.

1. Binder to consist of a mixture of synthetic resins, at least one of which is solid at room temperature, and high boiling point plasticizer.
2. Solid maleic-modified glycerol ester resin is at least one-third of the binder composition and is no less than 8 percent by weight of the entire material formulation.
3. The binder contains no petroleum based hydrocarbon resins.

E. Titanium Dioxide. Provide Rutile Type titanium dioxide conforming to ASTM D476.

F. Flash Point. Material flashpoint no less than 475 degrees F when tested in accordance with ASTM D92.

1071.3.2 Glass Beads.

A. Provide AASHTO M247 Type 1 glass beads with the following additional properties:

1. Have moisture resistant coating which passes AASHTO T346 Moisture Resistant Coating Test,
2. Have a minimum of 70 percent true spheres on each sieve and 80 percent true spheres overall when tested in accordance with ASTM D1155.

1071.3.3 Retroreflectivity.

A. Obtain the following minimum reflectivity values when tested with a Retroreflectometer with 30-meter geometry, or Department approved equal:

1. 300-millicandellas for white lines.
2. 200-millicandellas for yellow lines.

1071.4 Preformed Thermoplastic Pavement Markings

A. General.

1. Provide a resilient preformed thermoplastic pavement marking material meeting the requirements of AASHTO M249.
2. The pavement marking material must adhere to pavement contours, breaks, and faults through the action of traffic at normal pavement temperatures.

3. Have resealing and patching characteristics.
4. Have the capability of fusing to itself to previously applied worn hydrocarbon or alkyd thermoplastic pavement markings.
5. Have adequate flexibility to allow installation without material cracking.

B. Installation Methods.

1. Use preformed thermoplastic pavement marking material that is fusible to new or existing PCC or bituminous concrete pavements through use of the heat of an infrared heater, the normal heat of a propane type torch, or blueflame heater. Use of adhesives, primers, or sealers will only be allowed for PCC pavement applications.
2. The product must not require the use of a grid template or require the creation of pattern grooves or other indentations in the asphalt or concrete surface prior to installing the material.
3. The product must not require the use of a compactor or similar equipment.
4. The individual pieces in each material segment must be factory assembled with a compatible material and interconnected so that in the field it is not necessary to assemble the individual pieces within a material segment.
5. The material must be able to be applied in temperatures down to 45 degrees F without any preheating or treatment of the material before application

C. Environmental Resistance.

1. Resistant to deterioration due to exposure to sunlight, water, oil, diesel fuels, gasoline, pavement oil content, salt, lubricants, hydraulic fluids, and adverse weather conditions once applied.
2. The preformed retroreflective thermoplastic material must not dissolve or smear after rubbing a small amount of motor oil on a small piece of the thermoplastic material for two minutes.

D. Heating Indicator. Provide regularly spaced and evenly distributed indents on the top of the preformed thermoplastic material that give a visual cue during application that the material has reached a molten state to allow for determination of satisfactory adhesion and embedment and gives a post-application visual cue that the application procedures have been followed.

E. Skid Resistance.

1. The surface of the preformed thermoplastic material is to contain factory applied nonskid material with a minimum hardness of 7 (Mohs scale).
2. The material must provide a minimum skid resistance value of 55 BPN when tested in accordance with ASTM E303.

F. Thickness.

1. Provide a material that covers the entire application area so that no part of the pavement surface is visible in the application area.
2. Have a minimum average thickness of 90-mils for all longitudinal lines and a thickness of 125-mils for all transverse lines and symbols/legends.

G. Bond Strength. Bond strength to pavement greater than 180 psi when tested in accordance with ASTM D4796.

H. Flash Point. Material flashpoint no less than 475 degrees F when tested in accordance with ASTM D92.

J. Retroreflectivity.

1. Obtain the following minimum reflectivity values when tested with a Retroreflectometer with 30-meter geometry, or Department approved equal:

   a. 300-millicandellas for white lines.

   b. 200-millicandellas for yellow and blue lines.

1071.5 Preformed Pavement Marking Tape

A. General.

1. Provide performed pavement marking tape conforming to ASTM D4505, Level I, Class 2 or 3, Skid Resistance Level A.
2. Use preformed pavement marking tape that is not affected by weather condition and is suitable for application on new or existing PCC or bituminous concrete pavements.
3. Use only markings capable of providing required retroreflectivity during both wet and dry conditions.
4. Provide material that resists deterioration by contact with highway deicing chemicals or because of the oil content of asphalt concrete pavement, or from oil droppings and other effects of traffic.
5. Provide a surface adhesive activator or primer sealer when not placed by in-laid method in accordance with manufacturer's recommendations.
6. Guaranteed with a manufacturer's warranty.

B. Composition.

1. The pavement marking is to consist of a mixture of high-quality polymeric materials and pigments with glass beads distributed throughout the base cross-sectional area, with a reflective layer of microcrystalline ceramic beads bonded to a durable polyurethane topcoat surface. Beads are to meet the requirements of 1071.5.C.
2. The patterned surface is to have approximately 50 percent plus or minus 15 percent of the surface area raised and presenting a near vertical face, angled from 0-degrees to 60-degrees, to traffic from any direction.
3. The channels between the raised areas are to be substantially free of exposed beads or particles.
4. The marking is to be manufactured without the use of lead chromate pigments or other similar, lead-containing chemicals.

C. Beads.

1. Index of Refraction.

   a. 'Dry-performing' beads bonded to the polyurethane-coated, patterned surface of the material are to have a minimum index of refraction of 1.70 when tested using the liquid oil immersion method.

b. 'Wet-performing' beads bonded to the polyurethane-coated, patterned surface of the material are to have a minimum index of refraction of 2.30 when tested using the liquid oil immersion method.

c. Beads mixed into the pliant polymer shall are to have a minimum index of refraction of 1.50 when tested by the liquid oil immersion method.

2. Acid Resistance.

a. The beads are to show resistance to corrosion of their surface after exposure to a 1% solution (by weight) of sulfuric acid.

b. The 1 percent acid solution is made by adding 5.7 cc of concentrated acid into 1000 cc of distilled water.

D. Color. The markings is to consist of white and/or yellow films with pigments selected and blended to conform to ASTM D6628.

E. Patchability. The pavement marking material is to be capable of use for patching worn areas of the same type in accordance with manufacturer's instructions.

F. Thickness.

1. Minimum caliper of 0.065-inches at the thickest portion of the patterned cross section.

2. Minimum caliper of 0.020-inches at the thinnest portion of the patterned cross section.

G. Tensile Strength. A minimum tensile strength of 80 psi when tested in accordance with ASTM D3759.

H. Ultimate Elongation. A minimum elongation of 15 percent when tested in accordance with ASTM D3759.

G. Retroreflectivity.

1. Obtain the minimum reflectivity values when tested with a Retroreflectometer with 30-meter geometry, or Department approved equal:

a. 500-millicandellas for white lines.

b. 300-millicandellas for yellow lines.

1071.6 Temporary Pavement Marking Tape

A. Use removable retroreflective pavement marking tape that can be readily removed without the use of heat, solvents, grinding, or sand blasting and not leave an objectionable residue when markings are removed. The tape must be capable of being removed without tearing into small pieces.

B. The tape shall consist of a mixture of polymeric materials, pigment, and glass beads distributed uniformly throughout its cross sectional area.

C. Use weather resistant removable tape markings capable of conforming to pavement contours, breaks, faults, etc. through the action of traffic at normal and climatic weather condition and show no signs of lifting, tearing, shrinkage or other indications of poor adhesion that may reduce its useful life.

D. The material must provide a minimum skid resistance value of 45 BPN when tested in accordance with ASTM E303.

E. Use markings that remain wet and dry reflective throughout its useful life.

F. Use markings that are pre-coated with a pressure sensitive adhesive and capable of adhering to bituminous concrete or PCC at temperatures as low as 50 degrees F in accordance with the manufacturer's recommendations. Provide and use a surface preparation adhesive as recommended by the manufacturer.

G. Retroreflectance. Obtain the following minimum reflectivity values when tested with a Retroreflectometer with 30-meter geometry, or Department approved equal:

1. 500-millicandellas for white lines
2. 300-millicandellas for yellow and blue lines.

1071.7 Blackout Pavement Marking Tape

A. Use removable tape that can be readily removed without the use of heat, solvents, grinding, or sand blasting and not leave an objectionable residue. The tape must be capable of being removed without tearing into small pieces.

B. The tape shall be a matte black, non-reflective, durable, pliant material consisting of a mixture of polymeric materials, pigments and a friction material evenly distributed throughout its cross-sectional area.

C. The tape shall be in widths or sizes sufficiently large to mask the existing markings which are to be temporarily covered.

D. The tape shall be capable of adhering to existing markings and bituminous concrete pavement in accordance with the manufacturer's instructions without the use of heat, solvents or other additional adhesives, and shall be immediately ready for traffic use after application.

E. The tape shall be pre-coated with a pressure sensitive adhesive and capable of adhering to the pavement and existing pavement markings under climatic and traffic conditions normally encountered in the construction work zone.

F. The material must provide a minimum skid resistance value of 45 BPN when tested in accordance with ASTM E303.

1071.8 Raised/ Recessed Pavement Markers

A. Use a cast iron housing that is snow plowable and meets the requirements of ASTM A536, Grade 72-45-84.

B. Use reflectors that meet the requirements of ASTM D4383.

C. Use pavement marker color combinations in accordance with the DE MUTCD.

1071.8.2 Epoxy Resin Adhesive.

A. Use an epoxy resin adhesive that meets the requirements of AASHTO M237, Type IV.

SECTION 1072 — SIGN POSTS

1072.1 Galvanized Telescoping Steel Sign Posts.

A. Square tube formed from galvanized sheet structure (physical) quality:

1. ASTM A653, Grade A.
2. ASTM A653 coating designation G90.

B. Regular spangle or formed from hot rolled carbon sheet steel structural (physical) quality:

1. ASTM A653, Grade 50.

C. Use 12-gauge steel for all square tubes.

D. Use hot-dipped galvanized cold rolled steel:

1. ASTM A653.
2. Coating designation G90, Grade 50, class 1 with regular spangle.
3. Do not allow damage to finished coating.
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. Use hot-dipped galvanized hot rolled steel, after forming.

1. ASTM A653.
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 measured at least 2-inches from the end of tube, 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
3. Measure convexity and concavity 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 is ± 2 1/8-inches.

G. Holes: All 4 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: Provide straight members that have a smooth uniform finish, with all holes and cut off ends free from burs. Ensure that telescoping freely occurs for consecutive sizes of tubes for 9 feet to 15 feet 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 with ANSI B1.1, with zinc plating. Install signs with 3/8-inch x 2 1/2-inch bolt with locknut and 1 1/2-inch O.D. washer.

L. Basepost: Provide 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 result in rejection of the damaged posts.

N. Submit FHWA acceptance letters documenting satisfaction of NCHRP Report 350 or MASH crash testing requirements.

1072.2 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.

B. Supply structural steel in accordance with Section 615.2 of the standard specifications.

C. Breakaway couplings:

1. Alloy steel that conforms to AISI 4340, 4130, or an equivalent material.
2. Minimum tensile yield stress of 175,000 PSI.
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:
   a. Type A 17,000-21,000 pounds
   b. Type B 47,000-57,000 pounds
5. Steel meeting requirements of ASTM A370.
6. Provide 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:
   a. Type A Yellow
   b. 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. Provide upper brackets incorporating the load concentrating member or base made from the following material:
   a. Type A Aluminum alloy 6061 T-6 or equivalent as part of brackets.
   b. Type B Stainless steel 416 or equivalent ASTM A582 steel with Rockwell hardness classification of C35-C45 tested in accordance with ASTM E18.
3. Use the type of base based on the contract requirements.
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 the 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 PSI.
3. Use hinge plates that have tensile breaking strength ranges as follows and in accordance with the contract:
   a. HI-10 11,450-13,900 pounds
   b. HI-1 16,400-19,700 pounds
   c. HI-2 6,700-8,100 pounds

F. Nuts, bolts, and cap screws:

1. Conform to ASTM F3125.
2. Within a hardness range of Rockwell C23 to C31 before hot-dip galvanizing per AASHTO M232/M232M.

1072.3 Breakaway I-Beam Sign Foundation Hardware.

A. Anchor bolts:

1. Fabricated from 304 stainless steel for the threaded ferrule portion.
2. Fabricated from 1058 steel rod and coil for the cage portion of the anchor.

B. Nuts, bolts, and cap screws:

1. ASTM A325.
2. Within a hardness range of Rockwell C23 to C31 before hot-dip galvanizing per AASHTO M232/M 232M.

SECTION 1073 — DELINEATORS

1073.1 High Performance Flexible Plastic Tubular Markers.

A. Tubular Marker posts:

1. Provide a post exhibiting good workmanship and free of burns, discoloration, contamination, and other objectionable marks or defects that affect the appearance or serviceability. Provide posts that are:

   a. Composed of flexible plastic;

   b. Resistant to impact, ultra violet light, ozone, and hydrocarbons; and

   c. Remain impact resistant from -30 degrees F to 140 degrees F.

B. Reflector:

1. Use impact resistant prismatic retroreflective sheeting meeting the requirements of the ASTM D4956.

1073.2 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 ASTM D4956.

2. Use delineator blank 3 1/4-inches in diameter.

3. Use sheet aluminum cover and reflective sheeting 0.063 inch thick.

B. Posts:

1. Use steel conforming to the provisions of ASTM A36 and galvanize after fabrication in accordance with the provisions of ASTM A123.

2. Use a “U” channel section, weighing approximately 1.12 pounds per foot, for steel posts for post mounted delineators and hazard markers.

3. Punch posts with at least three 3/8-inch holes on the centerline, spaced at 4-inch centers, beginning 1 1/2-inches from the top before galvanizing.

1073.3 Barrier Mounted Delineators.

A. Delineators - Provide 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.

2. Contains UV-stabilized polymers.

3. Pre-drilled holes for bolt and stud mounting.

4. Minimum 12 square inches of prismatic reflective sheeting meeting the requirements of ASTM D4956.

5. 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,

a. Equip surface facing traffic:

i. Right Side of Roadway - white or silver sheeting

ii. Left side of roadway – yellow sheeting

b. Equip the back surface of delineators with red reflective sheeting.

2. On any undivided highway, equip all delineators with white or silver sheeting on the front and back.

1073.4 Flexible Delineators

A. General

1. Rebounds after impact.

2. Resistant to UV exposure and extreme temperature changes.

3. Minimum dimensions

a. 60-inches tall, before installation

b. Outer width minimum 3 ¾-inches

c. Decal mounting area width 3-inches

SECTION 1074 — ELECTRICAL CABLE AND SPLICING

1074.1 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 contract.
   b. THHN or THWN rated as noted on the contract.
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.
   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 and as directed by the engineer.
3. Independent test results to verify specification compliance:
   a. Costs of testing are incidental to the supplied cable item.
4. Supply cables on reels with each reel containing 1 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. Provide tracer line with a width shall not exceeding 3/20-inch when measured perpendicular to the edge of the line.
7. Provide tracer lines on a conductor such that the total width of the tracer line is less than one-half the total circumference of the conductor.

C. Emergency pre-emption receiver cable.

1. 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 2-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 2 conductors are AWG # 14 stranded copper.

1074.2 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. Do not use plated connectors fabricated from metals other than copper.
   c. Use bolted type connectors for splicing bare ground conductors.
   d. Wrap compression connector 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, 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 a 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 1 contact on a conductor and after insertion into its proper position within the load side plug housing, securely retain it. Preassemble the other contact for retention within a Y insert body.
      ii. A line side Y housing with 2 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 2 water seal cable ports.

iv. 2 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 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 maintains 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.

F. Tape – Use a vinyl electrical tape that has a PVC base with rubber-based pressure sensitive adhesive, a minimum of 7 mils thick, 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 and below:

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 before 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 1/2-inches 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 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 acceptable for use at 61 degrees F.

SECTION 1075 — TRAFFIC SIGNAL HEADS

1075.1 LED Traffic Signal and Pedestrian Signal Modules.

A. Provide materials and workmanship in conformance with the standards of the ASTM and ANSI where applicable.

B. Provide all electrical equipment conforming to the standards of NEMA, UL, and IEEE wherever applicable.

C. Perform all work to the state of the art, best practices as used by the industry, and the manufacturer's recommendations, whichever represents the highest standard. A representative of the Department is available to identify state of the art practices and to determine what constitutes the highest standard. The contractor is not entitled to an increase in the contract time or contract price for performing work to the state of the art or the highest standard.

D. Show by field review and by documents required as part of the contract that proposed materials will perform as required.

1075.2 LED Traffic Signal Modules.

A. Provide all LED modules for vehicle traffic signal heads conforming to the current ITE and DE MUTCD requirements.

B. Provide the circular LED modules in 1 of 6 types, as required by the contract:

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.

C. Provide the arrow LED modules in 1 of 3 types, as required by the contract:

1. 12-inch red arrow LED module.
2. 12-inch yellow arrow LED module.
3. 12-inch green arrow LED module.

D. The following are the detailed 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. Use the same mounting hardware used to secure the assembly to the traffic signal section, when replacing an incandescent reflector assembly 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 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 so that it is weatherproof. Provide a power supply 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 with 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 a 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 3 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 is 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 1 used with incandescent lamps. Do not use lenses that depict a “honeycomb” effect of the display.

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. Do not allow fluctuations in line voltage over the operating voltage range that affect luminous intensity by more than +/- 10 percent. Do not allow visible illumination from the module when the applied voltage is less than 35 VAC RMS.

b. Provide modules that meet the maximum and nominal wattage requirements of “ENERGY STAR Program Requirements for Traffic Signals.”

c. Provide wiring and terminal blocks that meet the requirements of VTCSH, Chapter 2, Section 13.02. Provide 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, NEC, and rated for service at 221 degrees F.

d. Wire the individual LEDs such that a catastrophic failure of 1 LED will result in the loss of not more than 5 percent of the module total light output. Wire the LEDs so that 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 have operational compatibility with NEMA traffic controller assemblies and meeting the standards set forth in NEMA standards publication TS-2 Traffic Controller Assemblies. Provide LED modules that have operational compatibility 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 perceived by the human eye during daylight and evening hours.

h. Provide LED signals fully capable of operating in the flashing mode.

i. A dimming feature is not required.

1075.3 Pedestrian Head LED Modules.

A. Provide LED modules conforming to 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 DE MUTCD, and the Standard Highway Signs and Markings, latest edition.

C. Provide each module as a fully encapsulated assembly that uses LEDs as the light source and a message lens. Wire the individual LEDs such that a failure of 1 or more LEDs will result in the loss of light from that LED only and the loss of not more than 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 2 digits.

F. Include the “hand” and “person” icons on all modules. If using the “countdown” icon 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 not using the “countdown” icon 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 to the electrical requirements of ITE, Pedestrian Traffic Control Signal Indicators: Light Emitting Diode (LED) signal modules, dated February 2011. Keep power consumption less than or equal to 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 F. Keep the individual LED driving current less than 10 milliamps for each icon at a temperature of 77 degrees F.
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. Do not permit fluctuations in line voltage within the range of 80 volts to 135 volts that affect luminous intensity by more than ± 10 percent. 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.
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 F.
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 1 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 F.

H. Photometric requirements:

1. Provide photometrics conforming to 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 1 to 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. The module must also meet all specifications in the operating temperature range of -40 degrees F to +165 degrees F.

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 provide 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.

1075.4 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.

1075.5 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, LED Quality Assurance Program. Failure of each supplied module to meet requirements of all these tests will be cause for rejection of the modules.

1075.6 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 performed on the modules 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.

1075.7 Warranty.

A. 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 5 years from the date of payment for the article. Renew the warranty for each part or component for another 5 years from the date of replacement of the article. 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.

1075.8 Manuals.

A. Supply a complete set of documentation that includes parts lists, operation details, maintenance schedules, and other information needed to install and operate the article.

1075.9 Signal Backplates.

A. Provide backplates with a flat, dull black (Federal Standard color number 595B-37038) Powder Coated Aluminum, polycarbonate, or ABS plastic with a minimum thickness of 1/8-inches and securely mounted on the signal housing. Mount backplates to traffic signal faces using stainless-steel self-tapping screws.

B. Manufacture signal head backplates for use with standard signal head assemblies, and compatible with the signal heads being backplated as to require no modifications to the backplate, to the dimensions of backplates in accordance with the contract. The backplate must be wide enough to extend all around the entire signal head assembly, 5-inches minimum at the widest portion of the signal head assembly.

C. Provide a minimum 2-inch-wide retroreflective yellow weather resistant prismatic sheeting tape border, comprised of ASTM D4956, Type XI (minimum) retroreflective sheeting around the entire perimeter of the backplate. The temperature rating for the backplate shall be -35 degrees F to 165 degrees F and the retroreflective tape shall not separate from the backplate within this temperature range.

1075.10 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 treat with a chromate aluminum oxide coating process per MIL-DTL-5541. Provide a finish coat using an oven bake.

D. 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 with ASTM B117 after 500-hours of salt spray test and have 50 percent gloss retention after 1,000 hours of weather meter test. Use 18-8 Type 304 stainless steel for all straight pins, wing nuts, washers, and bolts.

E. 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. Provide 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.

F. 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.

G. Equip the housing with hinges, as lugs cast onto the side of the housing or inside the housing, and locking devices for the door.

H. Provide a one-piece, corrosion resistant, aluminum alloy die-casting, in black (federal standard color number 595B-17038) housing door for each section. Provide 2 hinge lugs cast on 1 side of the door and 2 latch points cast on the other side. Attach the door to the housing by means of 2 straight pins. Equip the door with 2 eye bolts and wing nuts on 1 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, upon closing the door, seals against a raised bead on the housing, making a positive seal. Equip the outer face of the door to have 4 holes equally spaced about the circumference of the lens opening, with 4 screws to accommodate a signal head visor. Equip the door to have at least 2 index points to enable positive orientation of the lens.

1075.11 Visors.

A. Provide visors, full circle, tunnel, or cap, as shown in the contract; formed of corrosion-resistant aluminum alloy sheet not less than 0.05-inch in thickness. Provide visors 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 removal occurs 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.

1075.12 Banding Hardware.

A. Provide BAND-IT 3/4-inch, 0.030-inch thickness, stainless steel banding material and 3/4-inch stainless steel buckles, per contract for signal head mounting.

1075.13 Pedestrian Signal Housing.

A. Provide 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 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 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 2 hinge lugs cast on top, and 2 latch points cast on the bottom. Attach the door to housing by 2 hinge pins. Provide 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, upon closing the door, will seal against a raised bead of the housing, making a positive seal.

D. Equip the field terminal assembly with a 3 terminal pair (6 screw) type terminal block for termination of the 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. Before assembling, thoroughly clean all aluminum elements and apply a chromate conversion coating inside and outside 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 F. 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.

1075.14 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 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 at no additional charge. Assume an average of 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 switches 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 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 F to

+165 degrees F 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 provide the sign for the pushbutton assembly to the contractor for installation as shown in the contract.

F. Provide all materials required to mount the pushbutton assembly in accordance with the contract.

1075.15 Rectangular Rapid Flashing Beacon (RRFB) Indication.

A. Provide two 5-inch x 2-inch minimum rapidly and alternately flashed rectangular yellow indications having LED-array based pulsing light sources, designed in accordance with FHWA interim approval IA-11 and current interpretations. The light intensity of the RRFB's indications shall be Society of Automotive Engineers (SAE) standard J595 certified to meet Class I.

B. Design the RRFB assembly so that, when activated, the two yellow indications in each RRFB shall flash in a rapidly alternating "wig-wag" flashing sequence (left light on, then right light on). Each of the two yellow indications of an RRFB shall have 70 to 80 periods of flashing per minute and shall have alternating, but approximately equal, periods of flashing light emissions and dark operation. During each of its 70 to 80 flashing periods per minute, the yellow indications on the left side of the RRFB shall emit two slow pulses of light after which the yellow indications on the right side of the RRFB shall emit four rapid pulses of light followed by a long pulse. The flash rate of each individual yellow indication, as applied over the full on-off sequence of a flashing period of the indication, shall not be between 5 and 30 flashes per second, to avoid frequencies that might cause seizures.

C. Design the flashing display to be normally dark and initiate operation only upon pedestrian actuation. Activation of the RRFB will be by pushbutton. The flashing display shall cease operation at a predetermined time after the pedestrian actuation. The duration of operation shall be programmable from 1-second to 100-seconds.

D. Supply the RRFB display housing finished in brushed aluminum or black powder coat. All exposed hardware shall be anti-vandal.

E. Provide all materials required to mount the RRFB assembly in accordance with the contract.

SECTION 1076 — SPAN WIRE AND MESSENGER WIRE

1076.1 Material Requirements.

Provide all span wire, messenger wire, and accessories new and free of defects. Use hardware meeting AASHTO M232, Class C requirements unless otherwise specified.

1076.1.1 Span Wire.

A. Span wire, 7/16-inch: use galvanized steel extra high-strength grade wire meeting ASTM A475 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 A475 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. 2 service sleeves – to anchor the loose ends of the span wire.
2. 2 strain insulators – minimum rated strength of 20,000-pounds.
3. 4 galvanized guy clamps – 6 inches in length, each complete with three 5/8-inch galvanized bolts and nuts, meeting AASHTO M232, 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. 4 strain plates.
2. 16 galvanized screws, 1/4-inch x 2 1/2-inches.
3. 4 guy hooks.
4. 4, 5/8-inch x 4 inches lag screws.

1076.1.2 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 2 galvanized nuts.
2. 2 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. 2 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.

1076.1.3 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 2 outside holes suitable for 1/2-inch bolts and 1 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 2 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 2 galvanized nuts.
3. Two 3-inches x 3-inches x 1/4-inch galvanized steel washers with 13/16-inch center hole.

1076.1.4 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

1077.1 Material Requirements.

Use hardware meeting AASHTO M232 Class C requirements, unless otherwise specified.

1077.1.1 Down Guy and Anchor

A. Provide stranded guy wire in accordance with Section 1076.1.1 and as specified in the contract.

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 used.
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 3/4-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. 2 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.

1077.1.2 Overhead Guy

A. Provide stranded guy wire in accordance with Section 1076.1.1, and as specified in the contract.

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. 2 parallel groove connectors - Blackburn #K2 – jumper clamp, Ilsco, or approved equal.

SECTION 1078 — SERVICE PEDESTALS AND SAFETY SWITCH

1078.1 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 contract 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. Provide circuit breakers with the current and voltage ratings and number of poles in accordance with the contract.
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 1,000 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. Provide nominal operating levels of this control that 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; tolerances of ± 20 percent for the specified value is 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:

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 in accordance with the contract.

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 as specified.

5. Provide 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, 2 windings, of the size and voltage ratings specified in the contract.

N. Enclosures:

1. Meet the NEMA type specified.

2. Dead front type weatherproof metal enclosed self-supporting structures, in accordance with the contract.

3. Free standing enclosures:

a. Fabricated from sheet aluminum and meet the requirements below.

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. 2 weep holes in the bottom.

iv. 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-inches long, 12-inches wide and 1-inch thick.

i. Install the filter so that it covers the vents and remains 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-inch.

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 degrees F.

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 degrees F.

P. Disconnect switches and utility connections:

1. NEMA standard KS 1.

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 of heavy duty design with quick make, quick break type operations, and visible blades.

4. Use a disconnect switch on the line side fusible with integral fuse puller.

5. Use a non-fusible disconnect switch on the load side.

6. Provide single phase disconnect switches that have 2 poles with a solid neutral and rated at 240 volts.

7. Provide 3 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

1079.1 Material Requirements.

A. Loop Wire

1. One-conductor #14 AWG cable in 1/4-inch flexible tubing consisting of cable preinstalled in a polyethylene (PE) plastic duct meeting IMSA 51-5, rated for 600 volts.
2. Provide a cable with a temperature tolerance range of at least -65 to 176 degrees F.
3. Provide a conductor of AWG #14 stranded copper.
4. Provide a cable with an outside diameter of 1/4-inches.

B. Flexible embedding sealer – A two-component polyester loop sealant that is highly durable and remains permanently flexible. Use a loop sealant capable of withstanding the corrosive effect of road salts, automotive fluids, jet fuel, gasoline, and extreme weather conditions. Use 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 recommendations.

SECTION 1080 — LIGHTING CONTROL CABINETS

1080.1 Cabinet Enclosure.

A. Enclosure rated NEMA 3R, NEMA 3RX, or NEMA 4X.

1. Enclosures shall be fabricated from 304L or 316L stainless steel or 5052-H32 aluminum.

B. Enclosure has door clamps, solid neoprene gaskets, welded seams, stainless steel external hardware, and continuous hinges with stainless steel pins.

C. NEMA 4X shall be dead front type weatherproof enclosed structure.

D. NEMA 3RX l cabinet shall be louvered vent in the front door with a removable air filter:

1. Filters are 16-inches 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.

2. Exhaust air is vented out of the cabinet between the top of the cabinet and the main access door:

a. Exhaust area screened with a screen type material having a maximum hole diameter of 1/8-inch.

E. Install 2 weep holes at the bottom.

F. Equip enclosure with a pad-lockable handle.

1080.2 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. Do not use single pole breakers with handle ties.

F. Breakers have current and voltage ratings, with number of poles in accordance with the contract.

G. Breakers are capable of accepting up to a #2 AWG conductor.

H. Treat breakers to resist fungus and remain ambiently compensated for the enclosure and proximity to adjacent breakers.

I. Provide a minimum of 2 spare circuit breakers.

1080.3 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 the 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. Tolerances of ± 20 percent are acceptable.

E. Photoelectric control is twist lock type.

1. Provide suitable mounting bracket with locking type receptacle and all other necessary mounting hardware.

1080.4 Contactors and Relays.

A. Permanent magnets hold the contactors.

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 in accordance with the contract.

1080.5 Panel boards.

A. Conforms to UL listed.

B. Panel board has a minimum of 12 spaces for branch circuit breakers.

C. Suitable for operating voltage in accordance with the contract.

D. Equipped with the number and size circuit breakers in accordance with the contract.

E. Circuit breakers are bolted to copper busses.

1. Buss ratings are in accordance with the contract.

F. Provide transient voltage surge suppressors (TVSS).

1080.6 Lightning Arresters.

A. Arresters are secondary type, with 0-650 volts RMS, and number of poles in accordance with the contract.

B. Provide suitable mounting brackets and all other necessary mounting hardware for arresters.

1080.7 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, in accordance with the contract.

C. For single phase cabinets, thermostat/humidistat is inline type, single pole, with an operating voltage of 120 VAC, rated at 10 amps, with a minimum range of 70 degrees F to 160 degrees F.

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 3 phase cabinets, thermostat/humidistat is inline type, 3 pole, with an operating voltage of 480 VAC, rated at 10 amps, with a minimum range of 70 degrees F to 160 degrees F.

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.

LIST OF TABLES

Table 105.12-1. Customary Values 38

Table 108.4-1. Acceptable CPM Schedule Activity Calendars..... 68

Table 108.4-2. CPM Schedule Filename Convention. 68

Table 108.4-3. Acceptable CPM Schedule Activity Calendars..... 71

Table 108.4-4. CPM Schedule Filename Convention 71

Table 108.7-1. Anticipated Weather Days per Month..... 80

Table 108.9-1. Schedule of Liquidated Damages..... 82

Table 207.5 -1. Payment for Additional Excavation Depth 121

Table 401.3-1. Minimum Ambient Air Temperature for Placement of Types of Bituminous Concrete... 132

Table 401.3-2. Tack Coat Application Rates..... 133

Table 501.5-1. Price Adjustments for Concrete Pavement Thickness Deficiency 149

Table 606.3-1. Minimum Tests Required in the Slurry Control Plan 204

Table 606.3-2. Horizontal Tolerances for Drilled Shafts 213

Table 610.3-1. Surface Temperature Requirements During Curing 239

Table 610.3-2. Maximum temperature differentials 241

Table 610.3-3. Minimum Strength Requirements 242

Table 610.3-4. Requirements for Concrete in Contact with Sea Water or Brackish Water 243

Table 610.3-5. Corrective Action and Prorated Payment for Concrete Strength 246

Table 615.3-1. ANSI Surface Roughness Values..... 271

Table 615.3-2. Maximum Straightening Temperature 272

Table 615.3-3. Minimum Required ASTM F3125 Bolt Tension (U.S. Customary Units) 276

Table 615.3-4. Nut Rotation from the Snug Condition Geometry of Outer Faces of Bolted Parts 277

Table 615.4-1. Mass Densities of Steel and Iron 281

Table 615.4-2. Department's Measurement of the Weight of Fillet Weld by Size in Inches. 282

Table 628.3-1. Sealing Repair Methods and Material Requirements. 339

Table 801.3-1. Holiday Lane Closure Restrictions by Day of the Week 426

Table 802.3-1. Arrow Board Minimum Size by Type 428

Table 850.2-1. Foot-Candle Point Table by HPS Luminaire Equivalent Wattage 536

Table 908.2-1 - Permanent Grass Seeding - Dry Ground (PGS-DG) 595

Table 908.2-2 - Grass Seeding - Stormwater Facility (GS-SF) 595

Table 908.2-3 - Permanent Grass Seeding - Subdivision Mix (PGS-SUB) 596

Table 908.2-4 - Temporary Grass Seeding (TGS) 596

Table 908.2-5 - Permanent Grass Seeding - Streambank (PGS-SB) 597

Table 908.3-1 Stabilization of Erodible Earth and Maximum Allowable Time to Stabilize 598

Table 908.5-1. Payment Schedule 601

Table 911.2-1. Soil Analysis Requirements 622

Table 911.2-2. Fertilizer Analysis Requirements 622

Table 1001.1-1. Dry Weight Percent Passing Square Mesh Sieves for Borrow Types 630

Table 1003.1-1. Fine Aggregate Gradation Requirements 632

Table 1004.2-1. Coarse Aggregate Gradation Requirements 633

Table 1004.2-2. Recycled Material Gradation Requirements 634

Table 1004.2-3. Additional Requirements for Recycled Materials 634

Table 1006.1-1. Riprap Gradation (Percent Passing (Square Openings) by Weight) 636

Table 1006.2-1. Channel Bed Fill Gradation (Percent Passing (Square Openings) by Weight) 636

Table 1010.1-1. Asphalt Release Agent Requirements 637

Table 1011.3-1. Non-Tracking Emulsified Asphalt Requirements. 638

Table 1014.2-1. Fine Aggregate Requirements 641

Table 1014.3-1. Coarse Aggregate Requirements 641

Table 1014.8-1. Nominal Maximum Aggregate Size Control Points, % Passing 645

Table 1014.8-2. Volumetric Property Requirements 646

Table 1014.8-3. PCS Control Point for Mixture Nominal Maximum Aggregate Sizes (NMAS) (% Passing) 646

Table 1015.2-1. Bituminous Material Properties 649

Table 1015.2-2. Test on Residue from Distillate 649

Table 1015.5-1. Aggregate Gradation Requirements 650

Table 1015.7-1. Mixture Property Requirements 651

Table 1021.1-1. Modifications to ASTM C1602 and ASTM C1603 654

Table 1022.8-1 Mix Design Methods 656

Table 1022.8-2. Classification of Aggregate Reactivity 657

Table 1022.8-3. Minimum Level of Supplementary Cementitious Material for Portland cement with Alkali content of ≤ 0.40 percent Na_2Oe 658

Table 1022.8-4. Minimum Level of Supplementary Cementitious Material for Portland cement with Alkali content of > 0.40 and ≤ 1.00 percent Na_2Oe 659

Table 1022.8-5. Minimum Level of Supplementary Cementitious Material for Portland cement with Alkali content of > 1.00 and ≤ 1.25 percent Na_2Oe 659

Table 1022.8-6. Tests and Criteria for Proposed Concrete Components 659

Table 1022.9-1 Concrete Classes for Structures 660

Table 1022.9-2. Concrete Nominal Slump by Work Type[1] 660

Table 1022.16-1 Self-Consolidating Concrete Requirements 664

Table 1024.1-1: Grade Requirements for Concrete Crack Repair Material 667

Table 1024.3-1: Grade Requirements for Concrete Spall Repair Material 667

Table 1025.2-1. UHPC Closure Pour Material Properties 669

Table 1025.3-1. UHPC Acceptance Testing 670

Table 1030.1-1. Approximate Size and Capacity of Riprap by Bag Type 671

Table 1032.3-1. Fusion Bonded Epoxy Coating Requirements 675

Table 1032.5-1 Prestressed Pile Tolerances 676

Table 1035.1-1 Mineral Slurry Requirements 680

Table 1035.2-1. Polymer Slurry Requirements 680

Table 1035.3-1. Water Slurry Requirements 681

Table 1039.5-1. Tensile Properties of Stud Sheer Connectors 686

Table 1039.5-2. Stud Shear Connectors Standard Dimensions and Tolerances (in inches) 687

Table 1045.1-1. Epoxy Coating Requirements 697

Table 1045.3-1. Silane-Based Concrete Sealer Requirements 697

Table 1045.4-1. High Molecular Weight Methacrylate (HMWM) Resin Properties 698

Table 1045.5-1. Traffic Bearing Membrane Requirements 699

Table 1045.5-2. Non-Traffic Bearing Membrane Requirements 699

Table 1045.6-1. Aesthetic Stain Composition 699

Table 1046.1-1. Mix Design Requirements 701

Table 1046.2-1. Polyester Polymer Concrete Overlay Gradation 702

Table 1046.2-2. Polyester Resin Binder Requirements 703

Table 1047.4-1. Epoxy Grout Test Values 706

Table 1048.1-1. Electrochemical Soil Properties 708

Table 1048.1-2. Soil Gradation Requirements 708

Table 1060.1-1. Geotextile Material Requirements 713

Table 1071.2-1. Component A Requirements, % by Weight 727

Table 1071.2-2 Black Contrast Marking Composition Requirements 729

Table 1071.2-3 Black Aggregate Gradation Requirements 729