Project Specifications

Gerald R. Ford International Airport Authority

Kent County, Michigan

C-418 Viewing Park Expansion

April 2025

2240980

Prein&Newhof

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Advertisement

Owner:	Gerald R. Ford International Airport Authority
Project Title:	C-418 Viewing Park Expansion
Project #:	2240980

1. RECEIPT OF BIDS

   Sealed bids for the above project will be received by Gerald R. Ford International Airport Authority of 5500 44th Street SE, Grand Rapids, Michigan until:

   2:00 pm (local time) on Monday, May 12, 2025

   at which time the bids will be publicly opened and read aloud.

2. PRE-BID MEETING

   A bidders information meeting will be held in International Room A at the Gerald R. Ford International Airport, 5500 44th Street Se, Grand Rapids, MI, 49512 on April 30, 2025 at 2:00 p.m. Attendance at the bidders information meeting is **optional** for all General Contractors wishing to submit a bid on the project. Minutes of the bidders information meeting will be forwarded to all plan holders as an addendum.

3. SCOPE OF PROJECT

   The project consists of furnishing all material and constructing the following:

   Construct an expansion of the Airport Viewing Parking including approximately 585 tons of hot mix asphalt, 12,650 square feet of concrete sidewalk, 15,350 cubic yards of embankment, 3,100 square yards of aggregate base, 1,100 square years of aggregate surface course, 1,350 cubic yards of subbase, miscellaneous storm sewer and underdrain, eight power pedestals and an electrical panel, pavement marking, signage and restoration.

   Including all necessary appurtenances and restoration.

4. EXAMINATION OF SPECIFICATIONS

   Contract documents will be delivered electronically and are also available at the offices of:

   Gerald R. Ford International Airport Authority, 5500 44th Street SE, Grand Rapids, MI 49512
   Prein&Newhof, 3355 Evergreen Drive NE, Grand Rapids, MI 49525
   And some local plan rooms.

5. DEPOSIT FOR DRAWINGS AND SPECIFICATIONS

Drawings and specifications are available online at www.preinnewhof.com/plan-room or at the 3355 Evergreen Drive NE, Grand Rapids, MI 49525 office of Prein&Newhof after 12:00 pm, Friday, April 18, 2025. Electronic drawings, specifications and bidding documents will be accessible/available only to those Bidders who have contacted the Gerald R. Ford Airport Purchasing Department. Bidder assumes sole risk for any project specifications and drawings, electronic or hard copy, obtained other than directly from the Gerald R. Ford International Airport or Prein&Newhof. Hard copy drawings and specifications are available for the fee of $220.00 dollars by contacting Prein&Newhof. Prein&Newhof Plan Room members who want to purchase the hard copy of the drawings only, may do so for $72.00 dollars. A $15 dollar charge will be added to all mailed drawings and/or specifications. Fees are payable by cash or check only and are not refunded.

6. FUNDING

The work to be performed under this contract will be financed and paid for by funds received from local funds.

7. BID SURETY

A bid bond, certified check, or cashier's check payable to Gerald R. Ford International Airport Authority in an amount equal to five percent (5%) of the total price shall accompany each bid. This surety shall bind the bidder for a period of Thirty (30) days after the receipt of bids.

8. DISADVANTAGED BUSINESS ENTERPRISE (DBE)

GFIAA encourages and solicits participation of qualified minority and women businesses consistent with the principle of utilizing the most highly qualified and competitive firms.

9. RIGHT TO REJECT BIDS

The Owner reserves the right to reject any or all bids and to waive any irregularities in bidding. No bid may be withdrawn after the scheduled closing time for receiving bids for at least ninety (90) days thereafter.

10. COMPLETION DATE

Phase 1 of the project shall be substantially completed by June 27, 2025.

A.J. Nye, Procurement Specialist
Gerald R. Ford International
Airport Authority
Kent County, Michigan

Instructions To Bidders

Owner:	Gerald R. Ford International Airport Authority, Kent County, Michigan
Project Title:	C-418 Viewing Park Expansion
Project #:	2240980

1. CONTRACT DOCUMENTS

   The contract documents consist of material outlined in Article 7 of the Agreement. Each Bidder shall carefully examine his copy of the contract documents for completeness. No claim will be allowed on the basis that the contract documents are not complete.

2. INTERPRETATION OF THE CONTRACT DOCUMENTS

   It is the intent of these contract documents to be clear, complete and consistent. If Bidder is of the opinion that any portion of the contract documents is ambiguous, inconsistent or contains errors or omissions Bidder shall, prior to submitting its bid, in writing request Engineer to clarify that portion of the contract documents as an addendum. This interpretation or correction will be made a part of the contract documents as an addendum. Any such addendum shall be mailed, faxed, e-mailed or delivered only to each person recorded as having received/downloaded a copy of the contract documents directly from Prein&Newhof.

   The last day an addendum will be issued is three (3) business days prior to the bid. Questions to be addressed in the addendum will be received through 5:00 p.m. five (5) business days prior to the bid.

   Only written addenda issued by the Engineer shall be binding. Oral interpretations, information or instructions by any office or employee of the Owner or Engineer are not authorized and therefore are not binding.

   Any conclusions or information obtained or derived from Contract Documents will be at the user's sole risk. Prein&Newhof will maintain the Master Copy (hard copy), from which all electronic copies are based in its Grand Rapids Office. In the case of any contract discrepancy, the Master Copy (hard copy) shall be considered the controlling document.

3. BIDDERS INVESTIGATION

   The Bidder will be responsible for inspecting the site of the proposed work to determine for himself all conditions under which he will be obligated to work. It is also expected that he will investigate and make his own determination concerning the available facilities for receiving, transporting, handling and storing construction equipment and materials, and concerning other local conditions that may affect his work.

4. BID PROPOSAL PREPARATION

A. Name, Address and Legal Status of Bidder

The name and legal status of the Bidder, Corporation, Partnership or an Individual, shall be stated in the Proposal. A corporation Bidder shall name the state in which its Articles of Incorporation are held, and must give the title of the official having authority, under the by-laws, to sign contracts. A partnership Bidder shall give the full names and addresses of all partners. An L.L.C. Bidder shall provide the full names and addresses of all members.

Anyone signing a proposal as an agent of another must submit, with his proposal, legal evidence of his authority to act as an authorized agent of the party.

The place of residence of each Bidder, or the office address in the case of a firm or company, with county and state, must be given after a signature.

B. Bid Surety

See ADVERTISEMENT "BID SURETY"

C. Proposal Form

The Bidder is to complete the Bid Proposal Documents that are included in the Project Specification book (online or hard copy), referring to the table of contents to identify the exact order of these documents. Regardless of how the bid documents are received, a hard copy (paper copy) of the Bid Proposal Documents must be submitted for bidding purposes. *No electronically-submitted Proposals will be accepted.* The Bid Proposal Documents include: Bid Proposal Checklist, Bid Proposal, and Bid Proposal – Unit Price.

The Bidder must provide the signed Bid Proposal Documents in either type written or hand written (in ink) form and clearly and completely set forth all required lump sum amounts, unit prices or other costs in a legible and understandable manner. Illegibility of any work or figure in the proposal may be sufficient cause for rejection of the proposal by the Owners. *No electronically-submitted Proposals will be accepted.*

Each proposal must be enclosed in a sealed envelope addressed to 5500 44th Street SE, Grand Rapids, MI, 49512 and labeled "Proposal for Gerald R. Ford International Airport Authority, Kent County, Michigan, C-418 Viewing Park Expansion." No electronically submitted Proposals will be accepted.

D. Proposal Data

Proposals shall be carefully prepared in strict accordance with contract requirements and these instructions and shall include all pertinent information required by the proposal form. Failure of the bidder to comply in any respect shall be grounds for rejection of the bidder's proposal.

The proposal for work is on a unit basis.

The bids will be based on the comparison of totals of the extensions of the stated unit prices. In case of an error in preparation of the bid form, the unit prices will be used.

No partial bids will be considered.

E. Experience and Qualifications

It is the intention of the Owner to award this contract to a Bidder that will perform and complete all work in compliance with the Contract Documents and in a workmanlike and professional manner. Bids are therefore only solicited from responsible Bidders known to be skilled, experienced and regularly engaged in work of similar character and magnitude to that covered by these contract documents.

After the opening of bids, when so requested by the Owner or Engineer, the Bidder will be required to provide documentation of the extent and nature of his experience in work of this kind and to furnish references as to his experience on projects of similar types and concerning contractor's ability to timely and within budget perform work of the type involved in this project. The successful Bidder shall submit a statement of his experience and financial status, a list of all jobs he now has underway, with the volume and percent completed. If the successful Bidder is an LLC, bidder shall provide, if requested, personal guarantees of its members.

In addition to the above, when so requested, the Bidder shall meet with the Owner's representatives and give further information in relation to his proposed construction plan, methodology, and schedule of operations, in order to determine the Bidder's qualifications, ability to perform the Work, and timely complete the Work in accordance with the contract requirements.

F. Return of Bid Deposits

The bid deposits of all Bidders, except the three lowest Bidders, will be returned within seven days after the opening of the bids. The bid deposits of the three lowest Bidders will be returned (1) within 48 hours after the contract shall have been awarded to the successful Bidder, the signed agreement has been delivered, and the required bonds have been approved by the Owner, or (2) after rejection of all bids.

5. WITHDRAWAL OF BIDS

Any Bidder who has submitted a proposal to the Owner may withdraw his bid at any time prior to the scheduled time for opening bids. No Bidder may withdraw his bid after the opening for a period of Thirty (30) days thereafter.

6. AWARD AND EXECUTION OF THE CONTRACT

The contract shall be deemed as having been awarded when formal Notice of Award shall have been duly provided by the Owner upon the Bidder.

The Bidder to whom the contract shall have been awarded will be required to execute an Agreement in the form included in the Contract Documents and to furnish sureties, insurance policies and certificates all as required within fifteen (15) days after the award. In case of his refusal or failure to do so, he will be considered to have abandoned all his rights and interest in the award, and his bid deposit may be declared forfeited to the Owner and the work may be awarded to another Bidder.

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Bid Proposal Checklist

Owner:	Gerald R. Ford International Airport Authority, Kent County, Michigan
Project Title:	C-418 Viewing Park Expansion
Project #:	2240980

This checklist is for the bidder's convenience and the Engineer's use. It should be reviewed thoroughly before submitting a bid.

- ☐ Bid submitted on time.
- ☐ Bid surety properly completed and enclosed.
- ☐ Addenda, if applicable, has been acknowledged and any revisions to the proposal completed.
- ☐ Bid proposal legally signed in ink.
- ☐ All unit prices are completed in ink.

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Bid Proposal

Owner:	Gerald R. Ford International Airport Authority
Owner Address:	5500 44th Street SE, Grand Rapids, MI 49512
Project Title:	C-418 Viewing Park Expansion
Bid Date & Time:	Monday, May 12, 2025 @ 2:00 pm Project #: 2240980

The undersigned, being familiar with the site, plans, specifications, and related documents, proposes to furnish all required labor, materials, tools and equipment to construct the project in accordance with the [unit prices/lump sum] on the following sheets.

Date Prepared: _____

Receipt of Addenda

Receipt of Addenda _____ through _____ is herby acknowledged.

Summary of Bids

Total Bid $ _____

The Owner reserves the right to accept or reject any or reject any or all bids and to waive any irregularities in the bidding. No partial bids will be accepted.

Contractors Signature

Contractor's Name	Email Address	Telephone Number
Business Address	City	Zip Code
Printed Name	Title	Date

_____
Signature

Seal (if bidder is a corporation)

Bid Proposal - Unit Prices

Owner:
Gerald R. Ford International Airport Authority

Project Title:
C-418 Viewing Park Expansion

Bid Date & Time:

Project #:
2240980

Item No.	Description	Quantity	Unit	Unit Price	Total Amount
1	Mobilization, Max 10%	1	LS		
2	Safety & Security	1	LS		
3	Tree, Rem, 19 inch to 36 inch	4	Ea		
4	Tree, Rem, 6 inch to 18 inch	3	Ea		
5	Embankment, CIP	15,350	Cyd		
6	Excavation, Earth	2,900	Cyd		
7	Soil Erosion and Sedimentation Control Adjustment	1,500	Dlr	$1.00	$1,500.00
8	Erosion Control, Check Dam, Stone	60	Ft		
9	Erosion Control, Silt Fence	700	Ft		
10	Subbase, CIP	1,350	Cyd		
11	Aggregate Base, 6 inch	3,100	Syd		
12	Aggregate Surface Cse, 6 inch	1,080	Syd		
13	Culv End Sect, Conc, 12 inch	4	Ea		
14	Culv, Cl B, 8 inch	160	Ft		
15	Culv, Cl B, Conc, 12 inch	48	Ft		
16	Sewer, Cl III, 12 inch, Tr Det A	118	Ft		
17	Dr Structure Cover, Type E	2	Ea		
18	Dr Structure, 24 inch dia	2	Ea		

Item No.	Description	Quantity	Unit	Unit Price	Total Amount
19	Underdrain, Subbase, 4 inch	585	Ft		
20	Underdrain, Cleanout	2	Ea		
21	Edge Trimming	585	Ft		
22	HMA, 4EML	335	Ton		
23	HMA, 5EML	250	Ton		
24	Curb and Gutter, Conc, Det F4	500	Ft		
25	Sidewalk, Conc, 4 inch	12,650	Sft		
26	Concrete Parking Rail	54	Ea		
27	Chain Link Gate	1	Ea		
28	Post, Steel, 3 pound	74	Ft		
29	Sign, Type IIIA	20.25	Sft		
30	Sign, Type IIIB	30	Sft		
31	Sign, Airport, Rem, Salv, Erect	1	Ea		
32	Hard Surface Sign Post	2	Ea		
33	Pipe Bollard, 6 Inch	6	Ea		
34	Pavt Mrkg, Ovly Cold Plastic, 12 inch, Cross Hatching, White	312	Ft		
35	Pavt Mrkg, Preformed Thermopl, Accessible Sym	2	Ea		
36	Pavt Mrkg, Waterborne, 4 inch, Yellow	900	Ft		
37	Pavt Mrkg, Waterborne, 2nd Application, 4 inch, Yellow	900	Ft		
38	Pavt Mrkg, Waterborne, for Rest Areas, Parks, and Lots, 4 inch, Blue	185	Ft		
39	Riprap, Plain	27	Syd		
40	Fertilizer, Chemical Nutrient, Cl B	195	Lb		

Item No.	Description	Quantity	Unit	Unit Price	Total Amount
41	Mulch Blanket, High Velocity	7,475	Syd		
42	Seeding, Mixture THV	355	Lb		
43	Topsoil Surface, Salv, 4 inch	7,475	Syd		
44	Conduit, Schedule 40, 2 inch	570	Ft		
45	Conduit, Schedule 80, 4 inch	60	Ft		
46	Conduit, DB, (1), 1 1/4 inch	120	LF		
47	Conduit, DB, (2), 1 1/4 inch	90	LF		
48	Conduit, DB, (3), 1 1/4 inch	90	LF		
49	Conduit, DB, (4), 1 1/4 inch	50	LF		
50	Conduit, DB, (8), 1 1/4 inch	65	LF		
51	Conduit, DB, (2), 2 inch	20	LF		
52	Feeder Cable in Conduit, 600V, 3#4, #10G, THWN-2	1,260	LF		
53	Service Feeder in Conduit 3 #3/0 THWN-2 (2 SETS)	80	LF		
54	HH, (Composite), (17”x 30”x 12”Deep Stackable)	3	EA		
				Total Bid:	

AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

This Agreement is by and between Gerald R. Ford International Airport Authority, 5500 44th Street SE, Grand Rapids, MI, 49512 ("Owner") and [Contractor Name & Address] ("Contractor").

Terms used in this Agreement have the meanings stated in the General Conditions and the Supplementary Conditions.

Owner and Contractor hereby agree as follows:

ARTICLE 1—WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows: C-418 Viewing Park Expansion, including approximately 585 tons of hot mix asphalt, 12,650 square feet of concrete sidewalk, 15,350 cubic yards of embankment, 3,100 square yards of aggregate base, 1,100 square years of aggregate surface course, 1,350 cubic yards of subbase, miscellaneous storm sewer and underdrain, eight power pedestals and an electrical panel, pavement marking, signage and restoration.

ARTICLE 2—THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows: *C-418 Viewing Park Expansion*

ARTICLE 3—ENGINEER

3.01 The Owner has retained Prein&Newhof, Choose an item.("Engineer") to act as Owner's representative, assume all duties and responsibilities of Engineer, and have the rights and authority assigned to Engineer in the Contract.

3.02 The part of the Project that pertains to the Work has been designed by Prein&Newhof.

ARTICLE 4—CONTRACT TIMES

4.01 *Time is of the Essence*

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 *Contract Times: Dates*

A. The Work will be substantially complete on or before **June 27, 2025 (Phase 1) and 30 calendar days (Phase 2)**, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before **October 31, 2025**.

4.03 ~~*Contract Times: Days*~~

A. ~~The Work will be substantially complete within **[number]** days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the~~

~~General Conditions within **[number]** days after the date when the Contract Times commence to run~~.

4.04 *Milestones*

A. Parts of the Work must be substantially completed on or before the following Milestone(s):

1. Milestone 1 **Phase 1 shall be substantially completed by June 27, 2025**

2. Milestone 2 **Phase 2 shall be substantially completed within 30 calendar days following notice to contract that a wetland permit has been obtained.**

4.05 *Liquidated Damages*

A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the Contract Times, as duly modified. The parties also recognize the delays, expense, and difficulties involved in proving, in a legal or arbitration proceeding, the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. *Substantial Completion:* Contractor shall pay Owner $**800.00** for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion, until the Work is substantially complete.

2. *Completion of Remaining Work:* After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner $**800.00** for each day that expires after such time until the Work is completed and ready for final payment.

3. *Milestones:* ~~Contractor shall pay Owner $**800.00** for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for achievement of Milestone 1, until Milestone 1 is achieved, or until the time specified for Substantial Completion is reached, at which time the rate indicated in Paragraph 4.05.A.1 will apply, rather than the Milestone rate~~.

4. Liquidated damages for failing to timely attain Milestones, Substantial Completion, and final completion are not additive, and will not be imposed concurrently.

B. If Owner recovers liquidated damages for a delay in completion by Contractor, then such liquidated damages are Owner's sole and exclusive remedy for such delay, and Owner is precluded from recovering any other damages, whether actual, direct, excess, or consequential, for such delay, except for special damages (if any) specified in this Agreement.

C. *Bonus:* ~~Contractor and Owner further recognize the Owner will realize financial and other benefits if the Work is completed prior to the time specified for Substantial Completion. Accordingly, Owner and Contractor agree that as a bonus for early completion, Owner shall pay Contractor $**[number]** for each day prior to the time specified above for Substantial Completion (as duly adjusted pursuant to the Contract) that the Work is substantially complete. The maximum value of the bonus will be limited to $**[number]**~~.

4.06 *Special Damages*

A. Contractor shall reimburse Owner (1) for any fines or penalties imposed on Owner as a direct result of the Contractor's failure to attain Substantial Completion according to the Contract Times, and (2) for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.02 for Substantial Completion (as duly adjusted pursuant to the Contract), until the Work is substantially complete.

B. After Contractor achieves Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times, Contractor shall reimburse Owner for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.02 for Work to be completed and ready for final payment (as duly adjusted pursuant to the Contract), until the Work is completed and ready for final payment.

C. The special damages imposed in this paragraph are supplemental to any liquidated damages for delayed completion established in this Agreement.

ARTICLE 5—CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents, the amounts that follow, subject to adjustment under the Contract:

A. ~~For all Work other than Unit Price Work, a lump sum of $~~**~~[number]~~**~~.~~

~~All specific cash allowances are included in the above price in accordance with Paragraph 13.02 of the General Conditions~~.

B. ~~For all Unit Price Work, an amount equal to the sum of the extended prices (established for each separately identified item of Unit Price Work by multiplying the unit price times the actual quantity of that item).~~

~~Unit Price Work~~					
~~Item No.~~	~~Description~~	~~Unit~~	~~Estimated Quantity~~	~~Unit Price~~	~~Extended Price~~
				~~$~~	~~$~~
				~~$~~	~~$~~
				~~$~~	~~$~~
				~~$~~	~~$~~
				~~$~~	~~$~~
~~Total of all Extended Prices for Unit Price Work (subject to final adjustment based on actual quantities)~~					~~$~~

~~The extended prices for Unit Price Work set forth as of the Effective Date of the Contract are based on estimated quantities. As provided in Paragraph 13.03 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer~~.

C. ~~Total of Lump Sum Amount and Unit Price Work (subject to final Unit Price adjustment) $**[number]**.~~

D. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

ARTICLE 6—PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 *Progress Payments; Retainage*

A. Owner shall make progress payments on the basis of Contractor's Applications for Payment on or about the 30th day of each month during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract.

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract.

a. **90** percent of the value of the Work completed (with the balance being retainage).

1) If 50 percent or more of the Work has been completed, as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage; and

b. **0** percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to **98** percent of the Work completed, less such amounts set off by Owner pursuant to Paragraph 15.01.E of the General Conditions, and less **100** percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the punch list of items to be completed or corrected prior to final payment.

6.03 *Final Payment*

A. Upon final completion and acceptance of the Work, Owner shall pay the remainder of the Contract Price in accordance with Paragraph 15.06 of the General Conditions.

6.04 *Consent of Surety*

A. Owner will not make final payment, or return or release retainage at Substantial Completion or any other time, unless Contractor submits written consent of the surety to such payment, return, or release.

6.05 *Interest*

A. All amounts not paid when due will bear interest at the rate of **0** percent per annum.

ARTICLE 7—CONTRACT DOCUMENTS

7.01 *Contents*

A. The Contract Documents consist of all of the following:

1. This Agreement.
2. Bonds:
    a. Performance bond (together with power of attorney).
    b. Payment bond (together with power of attorney).
3. General Conditions.
4. Supplementary Conditions.
5. Specifications as listed in the table of contents of the project manual.
6. Drawings (not attached but incorporated by reference) consisting of twelve (12) sheets with each sheet bearing the following general title: Viewing Park Expansion.
7. Addenda (numbers **[number]** to **[number]**, inclusive).
8. Exhibits to this Agreement (enumerated as follows):
    a. **Contractor's Bid (pages 1 to 4, inclusive)**
    b. Insurance Specifications (pages 1 to 13, inclusive).
    c. The 2020 Standard Specifications for Construction adopted by the Michigan Department of Transportation are hereby incorporated into these contract documents.
    d. [List other required attachments (if any), such as documents required by funding or lending agencies]
9. The following which may be delivered or issued on or after the Effective Date of the Contract and are not attached hereto:
    a. Notice to Proceed.
    b. Work Change Directives.
    c. Change Orders.
    d. Field Orders.
    e. Warranty Bond, if any.

B. The Contract Documents listed in Paragraph 7.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 7.

D. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.

ARTICLE 8—REPRESENTATIONS, CERTIFICATIONS, AND STIPULATIONS

8.01 *Contractor's Representations*

A. In order to induce Owner to enter into this Contract, Contractor makes the following representations:

1. Contractor has examined and carefully studied the Contract Documents, including Addenda.

2. Contractor has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

3. Contractor is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.

4. Contractor has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.

5. Contractor has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.

6. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and (c) Contractor's safety precautions and programs.

7. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.

8. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

9. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

10. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

11. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

8.02 *Contractor's Certifications*

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 8.02:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

8.03 *Standard General Conditions*

A. Owner stipulates that if the General Conditions that are made a part of this Contract are EJCDC® C-700, Standard General Conditions for the Construction Contract (2018), published by the Engineers Joint Contract Documents Committee, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, through a process such as highlighting or "track changes" (redline/strikeout), or in the Supplementary Conditions.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement.

This Agreement will be effective on _____ (which is the Effective Date of the Contract).

Owner:	Contractor:
Gerald R. Ford International Airport Authority *(typed or printed name of organization)*	 *(typed or printed name of organization)*
By: _____ *(individual's signature)*	By: _____ *(individual's signature)*
Date: _____ *(date signed)*	Date: _____ *(date signed)*
Name: _____ *(typed or printed)*	Name: _____ *(typed or printed)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed)* *(If **[Type of Entity]** is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)*
Attest: _____ *(individual's signature)*	Attest: _____ *(individual's signature)*
Title: _____ *(typed or printed)*	Title: _____ *(typed or printed)*
Address for giving notices: 5500 44th Street SE Grand Rapids, MI 49512	Address for giving notices:
Designated Representative: Name: A J Nye *(typed or printed)* Title: Procurement Specialist *(typed or printed)* Address: 5500 44th Street SE Grand Rapids	Designated Representative: Name: _____ *(typed or printed)* Title: _____ *(typed or printed)* Address:
Phone: (616) 233-6251 Email: anye@grr.org *(If **[Type of Entity]** is a corporation, attach evidence of authority to sign. If **[Type of Entity]** is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)*	Phone: _____ Email: _____ License No.: _____ *(where applicable)* State: _____

PERFORMANCE BOND

Contractor	**Surety**
Name:	Name:
Address *(principal place of business)*:	Address *(principal place of business)*:
Owner	**Contract**
Name: Gerald R. Ford Int'l Airport Authority	Description *(name and location)*:
Mailing address *(principal place of business)*:	C-418 Viewing Park Expansion 4820 Kraft Ave SE, Grand Rapids, MI
5500 44th Street SE Grand Rapids, MI 49512	Contract Price:
	Effective Date of Contract:

Bond

Bond Amount:

Date of Bond:

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 16

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

Contractor as Principal	Surety
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title:	Title:
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title:	Title:

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:

    3.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;

    3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and

    3.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.

4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

    5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

    5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

    5.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or

    5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or

5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:

   7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

   7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

   7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.

10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.

12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such

statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions

    14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

    14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.

    14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

    14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

    14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.

15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.

16. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

PAYMENT BOND

Contractor	**Surety**
Name:	Name:
Address *(principal place of business)*:	Address *(principal place of business)*:
Owner	**Contract**
Name: Gerald R. Ford Int'l Airport Authority	Description *(name and location)*:
Mailing address *(principal place of business)*:	C-418 Viewing Park Expansion 4820 Kraft Ave SE, Grand Rapids, MI
5500 44th Street SE Grand Rapids, MI 49512	Contract Price:
	Effective Date of Contract:

Bond

Bond Amount:

Date of Bond:

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 18

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

Contractor as Principal	Surety
_____	_____
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____	By: _____
(Signature)	*(Signature)(Attach Power of Attorney)*
Name: _____	Name: _____
(Printed or typed)	*(Printed or typed)*
Title: _____	Title: _____
Attest: _____	Attest: _____
(Signature)	*(Signature)*
Name: _____	Name: _____
(Printed or typed)	*(Printed or typed)*
Title: _____	Title: _____

Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.

2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.

4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.

5. The Surety's obligations to a Claimant under this Bond will arise after the following:

    5.1. Claimants who do not have a direct contract with the Contractor

        5.1.1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and

        5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).

    5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).

6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.

7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

    7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and

    7.2. Pay or arrange for payment of any undisputed amounts.

    7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.

9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.

11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.

13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.

14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. Definitions

    16.1. *Claim*—A written statement by the Claimant including at a minimum:

        16.1.1. The name of the Claimant;

        16.1.2. The name of the person for whom the labor was done, or materials or equipment furnished;

        16.1.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;

        16.1.4. A brief description of the labor, materials, or equipment furnished;

16.1.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;

16.1.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;

16.1.7. The total amount of previous payments received by the Claimant; and

16.1.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.2. *Claimant*—An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond is to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

16.3. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

16.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

16.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.

17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.

18. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.

3. *Application for Payment*—The document prepared by Contractor, in a form acceptable to Engineer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

5. *Bidder*—An individual or entity that submits a Bid to Owner.

6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.

7. *Bidding Requirements*—The Advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.

8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.

9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.

10. *Claim*

a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by

Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.

b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.

c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.

d. A demand for money or services by a third party is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.

12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.

13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.

14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.

15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.

16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.

17. *Cost of the Work*—See Paragraph 13.01 for definition.

18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.

19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.

20. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.

21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or

communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

22. *Engineer*—The individual or entity named as such in the Agreement.

23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.

24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.

    a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.

    b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.

    c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.

25. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.

27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.

28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.

29. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.

30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.

31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.

32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.

33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.

34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.

35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals.

36. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.

38. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.

39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.

40. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.

41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers' instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.

42. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part

thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion of such Work.

43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.

44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.

45. *Supplier*—A manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.

46. *Technical Data*

    a. Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.

    b. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.

    c. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.

47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.

48. *Unit Price Work*—Work to be paid for on the basis of unit prices.

49. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.

50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives*: The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. *Day*: The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*: The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

1. does not conform to the Contract Documents;

2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

3. has been damaged prior to Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or Paragraph 15.04).

E. *Furnish, Install, Perform, Provide*

1. The word "furnish," when used in connection with services, materials, or equipment, means to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word "install," when used in connection with services, materials, or equipment, means to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words "perform" or "provide," when used in connection with services, materials, or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.

4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words "furnish," "install," "perform," or "provide," then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

F. *Contract Price or Contract Times*: References to a change in "Contract Price or Contract Times" or "Contract Times or Contract Price" or similar, indicate that such change applies to (1) Contract Price, (2) Contract Times, or (3) both Contract Price and Contract Times, as warranted, even if the term "or both" is not expressed.

G. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Performance and Payment Bonds; Evidence of Insurance*

A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).

B. *Evidence of Contractor's Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.

C. *Evidence of Owner's Insurance*: After receipt of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each additional insured (as identified in the Contract), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.

4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.

B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.

C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.

C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.

D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.

E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.

F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

G. Nothing in the Contract Documents creates:

1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or

2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 *Reference Standards*

A. *Standards Specifications, Codes, Laws and Regulations*

1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Contractor's Verification of Figures and Field Measurements*: Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.

2. *Contractor's Review of Contract Documents*: If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer take

precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:

a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.

B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.

C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

A. Contractor and its Subcontractors and Suppliers shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or

2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein precludes Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the 30th day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work may be done at the Site prior to such date.

4.03 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.

B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times.

B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:

1. Severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
2. Abnormal weather conditions;
3. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and
4. Acts of war or terrorism.

D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:

1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.
3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.

E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:

1. The circumstances that form the basis for the requested adjustment;
2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.

Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the

effect of the delay, disruption, or interference on the critical path to completion of the Work.

F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.

G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor in writing of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.

2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise;

(b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

B. *Removal of Debris During Performance of the Work*: During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will conform to applicable Laws and Regulations.

C. *Cleaning*: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading of Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data;

2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data; and

3. Technical Data contained in such reports and drawings.

B. *Underground Facilities*: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

C. *Reliance by Contractor on Technical Data*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b.

D. *Limitations of Other Data and Documents*: Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;
3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or
4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

5.04 *Differing Subsurface or Physical Conditions*

A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:

1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;
2. is of such a nature as to require a change in the Drawings or Specifications;
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. *Engineer's Review*: After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.

C. *Owner's Statement to Contractor Regarding Site Condition*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement

to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.

D. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

E. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

    a. Such condition must fall within any one or more of the categories described in Paragraph 5.04.A;

    b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,

    c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:

    a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise;

    b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or

    c. Contractor failed to give the written notice required by Paragraph 5.04.A.

3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.

4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities.

Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

5.05 *Underground Facilities*

A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:

1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;

2. complying with applicable state and local utility damage prevention Laws and Regulations;

3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;

4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and

5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.

B. *Notice by Contractor*: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated on the Drawings with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing regarding such Underground Facility.

C. *Engineer's Review*: Engineer will:

1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;

2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;

3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and

4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.

During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

D. *Owner's Statement to Contractor Regarding Underground Facility*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written

statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.

E. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

F. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

   a. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;

   b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and

   c. Contractor gave the notice required in Paragraph 5.05.B.

2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.

3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

5.06 *Hazardous Environmental Conditions at Site*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;

2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and

3. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.

E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.

G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.

H. If, after receipt of such written notice, Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court, arbitration, or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Contract.

B. Contractor shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Contract.

C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the Contract, except as provided otherwise by Laws or Regulations, and must be issued and signed by a surety named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

D. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.

E. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.

F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.

G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.

H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

6.02 *Insurance—General Provisions*

A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.

B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the

required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

C. Alternative forms of insurance coverage, including but not limited to self-insurance and "Occupational Accident and Excess Employer's Indemnity Policies," are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.

D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.

E. Owner shall deliver to Contractor, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Owner has obtained and is maintaining the policies and coverages required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, and full disclosure of all relevant exclusions. In any documentation furnished under this provision, Owner may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those relevant to this Contract.

F. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

H. Contractor shall require:

1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and

2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.

I. If either party does not purchase or maintain the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.

J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.

K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.

L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.

M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.

N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

6.03 *Contractor's Insurance*

A. *Required Insurance*: Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions.

B. *General Provisions*: The policies of insurance required by this Paragraph 6.03 as supplemented must:

1. include at least the specific coverages required;

2. be written for not less than the limits provided, or those required by Laws or Regulations, whichever is greater;

3. remain in effect at least until the Work is complete (as set forth in Paragraph 15.06.D), and longer if expressly required elsewhere in this Contract, and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract;

4. apply with respect to the performance of the Work, whether such performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable; and

5. include all necessary endorsements to support the stated requirements.

C. *Additional Insureds*: The Contractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies, if required by this Contract, must:

1. include and list as additional insureds Owner and Engineer, and any individuals or entities identified as additional insureds in the Supplementary Conditions;

2. include coverage for the respective officers, directors, members, partners, employees, and consultants of all such additional insureds;

3. afford primary coverage to these additional insureds for all claims covered thereby (including as applicable those arising from both ongoing and completed operations);

4. not seek contribution from insurance maintained by the additional insured; and

5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

6.04 *Builder's Risk and Other Property Insurance*

A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.

B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.

C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.

D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.

E. *Insurance of Other Property; Additional Insurance*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

6.05 *Property Losses; Subrogation*

A. The builder's risk insurance policy purchased and maintained in accordance with Paragraph 6.04 (or an installation floater policy if authorized by the Supplementary Conditions), will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.

1. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils, risks, or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused.

2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.

B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.

1. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.

C. The waivers in this Paragraph 6.05 include the waiver of rights due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other insured peril, risk, or cause of loss.

D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

6.06 *Receipt and Application of Property Insurance Proceeds*

A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor shall cause such services to be provided by a properly licensed design professional, at

Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall maintain good discipline and order at the Site.

B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.

C. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site will be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.04 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.

B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment must be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.05 *"Or Equals"*

A. *Contractor's Request; Governing Criteria*: Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.

1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:

    a. in the exercise of reasonable judgment Engineer determines that the proposed item:

        1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

        2) will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;

        3) has a proven record of performance and availability of responsive service; and

        4) is not objectionable to Owner.

    b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:

        1) there will be no increase in cost to the Owner or increase in Contract Times; and

        2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.

C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.

E. *Treatment as a Substitution Request*: If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

7.06 *Substitutes*

A. *Contractor's Request; Governing Criteria*: Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.

1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.

2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:

   a. will certify that the proposed substitute item will:

      1) perform adequately the functions and achieve the results called for by the general design;

      2) be similar in substance to the item specified; and

      3) be suited to the same use as the item specified.

   b. will state:

      1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;

      2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and

      3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.

   c. will identify:

      1) all variations of the proposed substitute item from the item specified; and

      2) available engineering, sales, maintenance, repair, and replacement services.

   d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in

Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.

B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.

C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.

F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

7.07 *Concerning Subcontractors and Suppliers*

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.

B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.

C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.

D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or

otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.

E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.

F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.

G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.

I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.

J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.

K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.

L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.

M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

7.08 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If an invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any

license fee or royalty to others, the existence of such rights will be disclosed in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.09 *Permits*

A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *Taxes*

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.11 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to

such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.

C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations.

B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.

C. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any

of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

E. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.

F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.

G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.

H. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).

J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.14 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as material safety data sheets) or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

7.16 *Submittals*

A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Contractor shall:

a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

b. determine and verify:

1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal;

2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;

c. confirm that the Submittal is complete with respect to all related data included in the Submittal.

2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.

3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.

B. *Submittal Procedures for Shop Drawings and Samples*: Contractor shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.

1. *Shop Drawings*

a. Contractor shall submit the number of copies required in the Specifications.

b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.

2. *Samples*

a. Contractor shall submit the number of Samples required in the Specifications.

b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer

may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.16.C.

3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Engineer's Review of Shop Drawings and Samples*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Work, comply with the requirements of the Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, or to safety precautions or programs incident thereto.

3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Contract Documents in a Field Order or other appropriate Contract modification.

5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.

6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.

7. Neither Engineer's receipt, review, acceptance, or approval of a Shop Drawing or Sample will result in such item becoming a Contract Document.

8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

D. *Resubmittal Procedures for Shop Drawings and Samples*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.

2. Contractor shall furnish required Shop Drawing and Sample submittals with sufficient information and accuracy to obtain required approval of an item with no more than two

resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges.

3. If Contractor requests a change of a previously approved Shop Drawing or Sample, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

E. *Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs*

1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:

a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the Contract Documents.

b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the Schedule of Submittals will be deemed accepted.

c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Contract Documents as to general form and content of the Submittal.

d. If any such Submittal is not accepted, Contractor shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.

2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.03. 2.04, and 2.05.

F. Owner-delegated Designs: Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer is entitled to rely on Contractor's warranty and guarantee.

B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:

1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and

2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.

C. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, or improper modification, maintenance, or operation, by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:

1. Observations by Engineer;

2. Recommendation by Engineer or payment by Owner of any progress or final payment;

3. The issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. Use or occupancy of the Work or any part thereof by Owner;

5. Any review and approval of a Shop Drawing or Sample submittal;

6. The issuance of a notice of acceptability by Engineer;

7. The end of the correction period established in Paragraph 15.08;

8. Any inspection, test, or approval by others; or

9. Any correction of defective Work by Owner.

E. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract will govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from losses, damages, costs, and judgments (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity

directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 *Delegation of Professional Design Services*

A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.

B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.

C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:

1. Checking for conformance with the requirements of this Paragraph 7.19;

2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and

3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.

F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.

G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

ARTICLE 8—OTHER WORK AT THE SITE

8.01 *Other Work*

A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.

D. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

8.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be

set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:

1. The identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;
2. An itemization of the specific matters to be covered by such authority and responsibility; and
3. The extent of such authority and responsibilities.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

A. If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. When applicable, any such equitable adjustment in Contract Price will be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times or Contract Price is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.

1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.
2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.

C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 *Replacement of Engineer*

A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents will be that of the former Engineer.

9.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 *Lands and Easements; Reports, Tests, and Drawings*

A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.

B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.

C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 *Change Orders*

A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 *Evidence of Financial Arrangements*

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract (including obligations under proposed changes in the Work).

9.12 *Safety Programs*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.

B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

10.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe, as an experienced and qualified design professional, the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.07. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Resident Project Representative*

A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.

B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

10.04 *Engineer's Authority*

A. Engineer has the authority to reject Work in accordance with Article 14.

B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.

C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.

D. Engineer's authority as to changes in the Work is set forth in Article 11.

E. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.05 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.06 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.07 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, will create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any

Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Contractor under Paragraph 15.06.A, will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs of which Engineer has been informed.

ARTICLE 11—CHANGES TO THE CONTRACT

11.01 *Amending and Supplementing the Contract*

A. The Contract may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.

B. If an amendment or supplement to the Contract includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order.

C. All changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Engineer.

11.02 *Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders covering:

1. Changes in Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;

2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;

3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters; and

4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Work Change Directives*

A. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.07 regarding change of Contract Price.

B. If Owner has issued a Work Change Directive and:

1. Contractor believes that an adjustment in Contract Times or Contract Price is necessary, then Contractor shall submit any Change Proposal seeking such an adjustment no later than 30 days after the completion of the Work set out in the Work Change Directive.

2. Owner believes that an adjustment in Contract Times or Contract Price is necessary, then Owner shall submit any Claim seeking such an adjustment no later than 60 days after issuance of the Work Change Directive.

11.04 *Field Orders*

A. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.

B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Changes involving

the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.

B. Such changes in the Work may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work must be performed under the applicable conditions of the Contract Documents.

C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

11.07 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.

B. An adjustment in the Contract Price will be determined as follows:

1. Where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);

2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or

3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).

C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit will be determined as follows:

1. A mutually acceptable fixed fee; or

2. If a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. For costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;

b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 percent;

c. Where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;

d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;

e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and

f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

11.08 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment in the Contract Times must comply with the provisions of Article 12.

B. Delay, disruption, and interference in the Work, and any related changes in Contract Times, are addressed in and governed by Paragraph 4.05.

11.09 *Change Proposals*

A. *Purpose and Content*: Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.

B. *Change Proposal Procedures*

1. *Submittal*: Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.

2. *Supporting Data*: The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.

    a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.

    b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

    The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.

3. *Engineer's Initial Review*: Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.

4. *Engineer's Full Review and Action on the Change Proposal*: Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

11.10 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12—CLAIMS

12.01 *Claims*

A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:

1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;

2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;

3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and

4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.

B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.

D. *Mediation*

1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.

2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal

and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.

3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.

E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.

F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.

G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13—COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 *Cost of the Work*

A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:

1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or

2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.

B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe

benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, which will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.

5. Other costs consisting of the following:

    a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

    b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

        1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.

    c. *Construction Equipment Rental*

        1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment,

machinery, or parts must cease when the use thereof is no longer necessary for the Work.

2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.

3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of builder's risk or other property insurance established in accordance with Paragraph 6.04), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded*: The term Cost of the Work does not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.

2. The cost of purchasing, renting, or furnishing small tools and hand tools.

3. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

5. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

6. Expenses incurred in preparing and advancing Claims.

7. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*

1. When the Work as a whole is performed on the basis of cost-plus-a-fee, then:

a. Contractor's fee for the Work set forth in the Contract Documents as of the Effective Date of the Contract will be determined as set forth in the Agreement.

b. for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work, Contractor's fee will be determined as follows:

1) When the fee for the Work as a whole is a percentage of the Cost of the Work, the fee will automatically adjust as the Cost of the Work changes.

2) When the fee for the Work as a whole is a fixed fee, the fee for any additions or deletions will be determined in accordance with Paragraph 11.07.C.2.

2. When the Work as a whole is performed on the basis of a stipulated sum, or any other basis other than cost-plus-a-fee, then Contractor's fee for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work will be determined in accordance with Paragraph 11.07.C.2.

E. *Documentation and Audit*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor and pertinent Subcontractors will establish and maintain records of the costs in accordance with generally accepted accounting practices. Subject to prior written notice, Owner will be afforded reasonable access, during normal business hours, to all Contractor's accounts, records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner. Pertinent Subcontractors will afford such access to Owner, and preserve such documents, to the same extent required of Contractor.

13.02 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances*: Contractor agrees that:

1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment for any of the foregoing will be valid.

C. *Owner's Contingency Allowance*: Contractor agrees that an Owner's contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor for Work covered by allowances, and the Contract Price will be correspondingly adjusted.

13.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, and the final adjustment of Contract Price will be set forth in a Change Order, subject to the provisions of the following paragraph.

E. *Adjustments in Unit Price*

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:

a. the quantity of the item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.

2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.

3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.01 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply with such procedures and programs as applicable.

14.02 *Tests, Inspections, and Approvals*

A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.

B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work will be governed by the provisions of Paragraph 14.05.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:

1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;

2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;

3. by manufacturers of equipment furnished under the Contract Documents;

4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and

5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests will be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.

F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering will be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

A. *Contractor's Obligation*: It is Contractor's obligation to assure that the Work is not defective.

B. *Engineer's Authority*: Engineer has the authority to determine whether Work is defective, and to reject defective Work.

C. *Notice of Defects*: Prompt written notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.

D. *Correction, or Removal and Replacement*: Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.

E. *Preservation of Warranties*: When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

F. *Costs and Damages*: In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved

by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work will be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

A. Engineer has the authority to require additional inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.

B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.

C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.

1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.

2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work will not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace defective Work as required by Engineer, then

Owner may, after 7 days' written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.

C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15—PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 *Progress Payments*

A. *Basis for Progress Payments*: The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments for Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.

B. *Applications for Payments*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.

2. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment must also be accompanied by: (a) a bill of sale, invoice, copies of subcontract or purchase order payments, or other documentation establishing full payment by Contractor for the materials and equipment; (b) at Owner's request, documentation warranting that Owner has received the materials and equipment free and clear of all Liens; and (c) evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

3. Beginning with the second Application for Payment, each Application must include an affidavit of Contractor stating that all previous progress payments received by Contractor have been applied to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

4. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

   a. the Work has progressed to the point indicated;

   b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and

   c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or

   b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

   a. to supervise, direct, or control the Work;

   b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;

c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;

d. to make any examination to ascertain how or for what purposes Contractor has used the money paid by Owner; or

e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.

6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:

a. the Work is defective, requiring correction or replacement;

b. the Contract Price has been reduced by Change Orders;

c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;

d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or

e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. *Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. *Reductions in Payment by Owner*

1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:

a. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;

c. Contractor has failed to provide and maintain required bonds or insurance;

d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;

e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;

f. The Work is defective, requiring correction or replacement;

g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;

h. The Contract Price has been reduced by Change Orders;

i. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;

j. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;

k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens; or

l. Other items entitle Owner to a set-off against the amount recommended.

2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed will be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.

3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld will be treated as an amount due as determined by Paragraph 15.01.D.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than 7 days after the time of payment by Owner.

15.03 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which will fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.

F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. At any time, Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through 15.03.E for that part of the Work.

2. At any time, Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.04 regarding builder's risk or other property insurance.

15.05 *Final Inspection*

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 *Final Payment*

A. *Application for Payment*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.12), and other documents, Contractor may make application for final payment.

2. The final Application for Payment must be accompanied (except as previously delivered) by:

a. all documentation called for in the Contract Documents;

b. consent of the surety, if any, to final payment;

c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.

d. a list of all duly pending Change Proposals and Claims; and

e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment

bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

B. *Engineer's Review of Final Application and Recommendation of Payment*: If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the final Application for Payment to Owner for payment. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Notice of Acceptability*: In support of its recommendation of payment of the final Application for Payment, Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 15.07.

D. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment and issuance of notice of the acceptability of the Work.

E. *Final Payment Becomes Due*: Upon receipt from Engineer of the final Application for Payment and accompanying documentation, Owner shall set off against the amount recommended by Engineer for final payment any further sum to which Owner is entitled, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions of this Contract with respect to progress payments. Owner shall pay the resulting balance due to Contractor within 30 days of Owner's receipt of the final Application for Payment from Engineer.

15.07 *Waiver of Claims*

A. By making final payment, Owner waives its claim or right to liquidated damages or other damages for late completion by Contractor, except as set forth in an outstanding Claim, appeal under the provisions of Article 17, set-off, or express reservation of rights by Owner. Owner reserves all other claims or rights after final payment.

B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted as a Claim, or appealed under the provisions of Article 17.

15.08 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the Supplementary Conditions or the terms of any applicable special guarantee required by the Contract Documents), Owner gives Contractor written notice that any Work has been found to be defective, or that Contractor's repair of any damages to the Site or adjacent areas has been found to be defective, then after receipt of such notice of defect Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

   1. correct the defective repairs to the Site or such adjacent areas;

   2. correct such defective Work;

   3. remove the defective Work from the Project and replace it with Work that is not defective, if the defective Work has been rejected by Owner, and

   4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting from the corrective measures.

B. Owner shall give any such notice of defect within 60 days of the discovery that such Work or repairs is defective. If such notice is given within such 60 days but after the end of the correction period, the notice will be deemed a notice of defective Work under Paragraph 7.17.B.

C. If, after receipt of a notice of defect within 60 days and within the correction period, Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others). Contractor's failure to pay such costs, losses, and damages within 10 days of invoice from Owner will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the failure to pay.

D. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

E. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

F. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph are not to be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times directly attributable to any such suspension. Any Change Proposal seeking such adjustments must be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment, or failure to adhere to the Progress Schedule);

2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;

3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or

4. Contractor's repeated disregard of the authority of Owner or Engineer.

B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) 10 days' written notice that Owner is considering a declaration that Contractor is in default and termination of the Contract, Owner may proceed to:

1. declare Contractor to be in default, and give Contractor (and any surety) written notice that the Contract is terminated; and

2. enforce the rights available to Owner under any applicable performance bond.

C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.

D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within 7 days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.

E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as

to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.

G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond will govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate for Convenience*

A. Upon 7 days' written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and

3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

B. Contractor shall not be paid for any loss of anticipated profits or revenue, post-termination overhead costs, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon 7 days' written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, 7 days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17—FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

A. *Disputes Subject to Final Resolution*: The following disputed matters are subject to final resolution under the provisions of this article:

1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full, pursuant to Article 12; and

2. Disputes between Owner and Contractor concerning the Work, or obligations under the Contract Documents, that arise after final payment has been made.

B. *Final Resolution of Disputes*: For any dispute subject to resolution under this article, Owner or Contractor may:

1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions;

2. agree with the other party to submit the dispute to another dispute resolution process; or

3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18—MISCELLANEOUS

18.01 *Giving Notice*

A. Whenever any provision of the Contract requires the giving of written notice to Owner, Engineer, or Contractor, it will be deemed to have been validly given only if delivered:

1. in person, by a commercial courier service or otherwise, to the recipient's place of business;

2. by registered or certified mail, postage prepaid, to the recipient's place of business; or

3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

18.02 *Computation of Times*

A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be

as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 *Limitation of Damages*

A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination of the Contract or of the services of Contractor.

18.07 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Assignment of Contract*

A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights under or interests in the Contract will be binding on the other party without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.09 *Successors and Assigns*

A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

18.10 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

SUPPLEMENTARY CONDITIONS

C-418 Viewing Park Expansion

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Caption and Introductory Statements

Supplementary Conditions

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, EJCDC C-700 (2018 Edition). All provisions which are not so amended or supplemented remain in full force and effect.

Unless otherwise noted, the terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added thereto.

ADDITIONS, DELETIONS AND CHANGES TO GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

SC-1.01 *Defined Terms*

SC-1.01 Add the following new paragraph immediately after Paragraph 1.01.A.22:

22.1 *Falsework*--temporary construction work on which a main work is wholly or partly built and/or supported until the main work is strong enough to support itself.

SC-1.01 Add the following new paragraph immediately after Paragraph 1.01.A.32:

32.1 *Project Manual* – the written documents prepared for, or made available for, procuring and constructing the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.

SC-1.02 *Terminology*

SC-1.02 Add the following new sentence immediately after the last sentence in Paragraph

1.02.B:

The use of any such term or adjective is not intended to and shall not be effective to relieve the Contractor of responsibility to comply with all Laws and Regulations applicable to the performance of the Work, or to perform the Work in accordance with the provisions of Article 7, or to comply with any other provision of the Contract Documents.

ARTICLE 2 - PRELIMINARY MATTERS

SC-2.03 *Before Starting Construction*

SC-2.03 Delete Paragraph 2.03.A in its entirety and insert the following in its place:

A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement, Contractor shall submit to Owner and Engineer for timely review:

1. A preliminary Progress Schedule indicating the times (number of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2. A preliminary Schedule of Submittals; and

3. A preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

SC-2.05 *Acceptance of Schedules*

SC-2.05 Delete Paragraph 2.05.A in its entirety and insert the following in its place:

A. Upon Owner's, Engineer's or Contractor's request at least ten days before submission of the first Application for Payment a conference, attended by Contractor, Owner, Engineer and others as appropriate, will be held to review for acceptability to Owner as provided below the schedules submitted in accordance with paragraph 2.03.A. If a schedule is not acceptable, Contractor shall have an additional ten days to make corrections and adjustments and to complete and resubmit the schedules. Upon notice by Owner, no progress

payment shall be made to Contractor until acceptable schedules are submitted and accepted by Owner.

1. The Progress Schedule will be acceptable to Owner if it provides an orderly progression of the Work to completion within any specified Milestones and the Contract Time, and if acceptable to Engineer. Such acceptance will not impose on Owner or Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Owner if acceptable to Engineer and if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Owner as to form and substance if it is acceptable to Engineer and if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

SC-3.01 *Intent*

SC-3.01 Add the following new sentence immediately after the last sentence in Paragraph 3.01.B:

Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated result will be provided whether or not specifically called for, at no additional cost to Owner.

SC-3.02 *Reference Standards*

SC-3.02.A.2 Delete Paragraph 3.02.A.2 in its entirety and insert the following in its place:

No provision of any such standard specification, manual, reference standard, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the part

of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the work or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

SC-3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

SC-3.03 Delete Sub-Paragraph 3.03.A.3 in its entirety and insert the following in its place:

3. Contractor shall not be entitled to any increase in the Contract Amount or Contract Time for any conflicts, errors, ambiguities or discrepancies in the Contract Documents that were known, or that should have been known to Contractor, or which could have been discovered by Contractor as part of its review of the bidding requirements and Contract Documents prior to bidding or its review of the Contract Documents prior to undertaking any part of the Work.

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

SC-4.01 *Commencement of Contract Times; Notice to Proceed*

SC-4.01 Delete Paragraph 4.01.A in its entirety and insert the following in its place:

A. The Contract Times will commence to run on the day indicated in the Notice to Proceed.

SC-4.05 *Delays in Contractor's Progress*

SC-4.05 Add the following new paragraph immediately after Paragraph 4.05.G

H. Contractor must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under Paragraph 4.05 within 30 days of the commencement of the delaying, disrupting, or interfering event.

ARTICLE 5 - SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

SC-5.03 *Subsurface and Physical Conditions*

SC-5.03.A Delete Paragraph 5.03.A in its entirety and insert the following in its place:

A. *Reports and Drawings:* The Contract Documents may identify:

1. Those soil borings, plans, drawings, surveys or other reports of explorations of subsurface conditions at or contiguous to the Site that Engineer has used in preparing the Contract Documents;

2. Those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site, (Except Underground Facilities) that Engineer has used in preparing the Contract Documents; and

3. Technical Data contained in such *Reports and Drawings.*

The soil borings, plans, drawings, surveys, technical data, and other documents referenced in Paragraphs 5.03.A.1, 2 and 3 are collectively called "*Reports and Drawings.*"

SC-5.03.C Delete Paragraph 5.03.C in its entirety and insert the following in its place:

C. *Reliance by Contractor Not Authorized.* Contractor may not rely upon the *Reports and Drawings* referenced in 5.03.A or make any claim against Owner, Engineer, or any of Owner's or Engineer's Consultants or Subcontractors related to the *Reports and Drawings*. This limitation includes but is not limited to:

1. The accuracy or completeness of such *Reports and Drawings* for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. The accuracy or completeness of other data, interpretations, opinions, and information contained in, shown on, or indicated in the *Reports and Drawings*; or

3. Any Contractor interpretation of or conclusion drawn from any of the *Reports and Drawings* or any other Technical Data, data, interpretations, opinions or information referenced in the *Reports and Drawings.*

The *Reports and Drawings,* including the information contained therein, are offered to the Contractor only as information relied upon by Engineer in the preparation of the Contract Documents, and the Contractor is solely responsible for confirming actual conditions. Neither the Engineer nor the Owner, nor the Consultants or Subcontractors of either have any responsibility for any conclusion, interpretation or analysis contained therein or made by the Contractor based upon the Contractor's review of the Reports *and Drawings*.

Neither Owner nor Engineer has any responsibility for and does not warrant that the soils or water table encountered during construction will be as shown in the *Reports and Drawings*.

SC-5.03.D Delete Paragraph 5.03.D in its entirety and insert the following in its place:

D. Contractor warrants that before submitting a bid the Contractor has determined the soil and subsoil conditions, including the water table elevation and the conditions to be encountered by Contractor in the performance of the Work and that said conditions and factors have been evaluated by Contractor and incorporated into his Contract with Owner. Contractor further warrants that the Contractor is fully aware of the soil conditions, subsoil conditions, water table and all applicable State and Federal Regulations related to the excavation, removal, transportation, placement and relocation of the materials involved in the Work to be performed by the Contractor and that Contractor

will complete the Work under whatever conditions he may encounter or create without extra cost, expense to or claim against the Owner or Engineer, their Consultants or Subcontractors.

Contractor has identified all locations where the Contractor's operations are near public roadways, the properties of railroads or contiguous physical structures. Work shall not take place until Contractor has made all arrangements necessary to identify the location and/or elevation of the roadways, the properties of railroads or contiguous physical structures and foundation or appurtenances and has taken all necessary steps to protect the roadways, the properties of railroads or contiguous physical structures from damage. Contractor is solely responsible for any and all damage to roadways, the properties of railroads or contiguous physical structures and any personal injury, death or property damage or consequential damages arising from Contractor's operations.

SC-5.04 *Differing Subsurface or Physical Conditions*

SC-5.04.A Delete Paragraph 5.04.A in its entirety and insert the following in its place:

A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed either:

1. is of such a nature as to require a change in the Contract Documents; or

2. is of an unusual nature and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, within 48 hours after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by paragraph 7.15), notify

Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so. If notice as provided in the section is not given, no change in Contract Price shall be considered or allowed.

SC-5.04.B Delete Paragraph 5.04.B in its entirety and insert the following in its place:

B. *Engineer's Review*: After receipt of written notice as required by Paragraph 5.04.A, Engineer will review the information provide by Contractor. If Engineer, in Engineer's sole discretion, determines that additional explorations and/or tests are needed to evaluate Contractor's belief that there are differing subsurface or physical conditions, then Contractor, at Contractor's sole expense, shall promptly undertake those additional explorations and/or tests, and provide the results to Engineer. Engineer will then review the information provided by Contractor along with any other information Engineer believes is pertinent, and advise Owner in writing (with a copy to Contractor) of Engineer's findings, conclusions and recommendations.

If after receipt of written notice as required by Paragraph 5.04.A, Engineer, in Engineer's sole discretion, determines that additional explorations and/or tests are not needed to evaluate Contractor's belief that there are differing subsurface or physical conditions, Engineer will review the information provided by Contractor, along with any other information Engineer believes is pertinent, and advise Owner in writing (with copy to Contractor) of Engineer's findings, conclusions and recommendations.

Owner reserves the right at its own expense to undertake additional exploration and/or testing. This reservation in no way waives the responsibility of the Contractor to undertake additional explorations and/or tests, if required, as set forth above.

SC-5.05 *Underground Facilities*

SC-5.05.A Delete Paragraph 5.05.A in its entirety and insert the following in its place:

A. *Contractor's Responsibilities*: The information and data shown or indicated in the Contract Documents with respect to existing

Underground Facilities at or adjacent to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others.

1. The Underground Facilities shown on or indicated in the Contract Documents are located according to the information available to the Engineer at the time of the preparation of the Contract Documents. Neither the Engineer nor the Owner guarantee the accuracy or completeness of any such information or data, including but not limited to information provided by the Owner;

2. The Contractor is solely responsible for identifying the actual location of all Underground Facilities and shall verify the location and/or elevations of the Underground Facilities prior to undertaking construction;

3. At all locations where the Contractor's operations are near, will cross or contact Underground Facilities, no part of the Work shall commence until Contractor has made all arrangements necessary to identify the location and/or elevation of the Underground Facility, including contacting MISS DIG, has notified the owner of the Underground Facility, and has taken all necessary steps to protect the Underground Facility from damage.

4. The cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

    a. reviewing and checking all information and data regarding Underground Facilities at the Site;

    b. complying with applicable state and local utility damage prevention Laws and Regulations;

    c. locating all Underground Facilities shown or indicated in the Contract Documents;

    d. verifying the actual location of those Underground

Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;

e. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction;

f. the safety and protection of all such Underground Facilities and related above ground structures, including but not limited to shoring, bracing, supporting and maintenance of all Underground Facilities and related above ground structures affected by the Contractor's operations;

g. repairing any damage to Underground Facilities and related above ground structures resulting from the Work; and

h. any personal injury, death or property damage or consequential damages arising from Contractor's Work.

5. In the event of the interruption of or damage to an Underground Facility as the result of Contractor's operations, the Contractor shall immediately notify the Underground Facility owner and shall take all steps necessary to cooperate with and assist the Underground Facility owner in the restoration and repair of the Underground Facility. Said repair work shall be continuous and shall not result in any delay of the Project or increased cost or expense to Owner, or claim against Owner, Engineer or their Consultants.

SC-5.05.B Delete Paragraph 5.05.B in its entirety and insert the following in its place:

B. *Notice by Contractor*: If an Underground Facility is uncovered or revealed at or adjacent to the Site which was not shown or indicated in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing

conditions affected thereby or performing any Work in connection therewith (except in an emergency as required paragraph 7.15), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.

SC-5.05.C Delete Paragraph 5.05.C in its entirety and insert the following in its place:

C. *Engineer's Review*: Engineer will review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. If Engineer concludes that a change in the Contract Documents is required, Engineer shall prepare recommendations to the Owner regarding the Contractor's resumption of Work in connection with the Underground Facility in question; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and advise Owner in writing of Engineer's findings, conclusions, and recommendations. At all times, Contractor shall be solely responsible for the safety and protection of such Underground Facility.

SC-5.05.F. Delete Paragraph 5.05.F.1 in its entirety and insert the following in its place:

F. *Possible Price and Times Adjustment*

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated in the Contract Documents, subject to the following:

a. Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Underground Facility in question;

b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;

c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and

d. Contractor gave the notice required in Paragraph 5.05.B.

SC-5.06 *Hazardous Environmental Conditions at Site*

SC-5.06.A Delete Paragraph 5.06.A in its entirety and insert the following in its place:

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. The following reports regarding Hazardous Environmental Conditions at the Site were utilized by the Engineer in the preparation of the Contract Documents:

a. *None*

2. The following drawings regarding Hazardous Environmental Conditions at the Site were utilized by the Engineer in the preparation of the Contract Documents:

a. *None*

3. Technical Data contained in such *Reports and Drawings.*

SC-5.06.B Delete Paragraph 5.06.B in its entirety and insert the following in its place:

B. *Reliance by Contractor Not Authorized:* Contractor may not make any Claim against Owner, Engineer or the Consultants of either with respect to:

1. The completeness of such reports, drawings and/or Technical Data, for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor, the cost of Work and safety precautions and programs incident thereto; or

2. The accuracy of any Technical Data, or any other data,

interpretations, opinions and information contained in such reports or shown or indicated on such drawings; or

3. Any Contractor interpretation of or conclusion drawn from any such report, drawing or Technical Data.

ARTICLE 6 - BONDS AND INSURANCE

6.02 *Insurance—General Provisions*

SC-6.02 Delete Paragraph 6.02.A in its entirety and insert the following in its place:

A. Owner and Contractor shall obtain and maintain insurance as required in this Article and in the Insurance Specification.

SC-6.02 Delete Paragraphs 6.02.B through 6.02.N in their entirety and replace with Insurance Specification.

6.03 *Contractor's Insurance*

SC-6.03 Delete Paragraph 6.03.A in its entirety and insert the following in its place:

A. *Required* Insurance: Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Insurance Specification.

SC-6.03 Delete Paragraphs 6.03.B through 6.03.C in their entirety and replace with Insurance Specification.

6.04 *Builder's Risk and Other Property Insurance*

SC-6.04 Delete the last sentence of Paragraph 6.04.A and insert the following in its place:

The specific requirements applicable to the builder's risk insurance are set forth in the Insurance Specification.

SC-6.04 Delete Paragraphs 6.04.B through 6.04.E in their entirety and replace with Insurance Specification.

6.05 *Property Losses; Subrogation*

SC-6.05 Delete Paragraphs 6.05.A through 6.05.D in their entirety and replace with Insurance Specification.

6.06 *Receipt and Application of Property Insurance Proceeds*

SC-6.06 Delete Paragraphs 6.06.A through 6.06.C in their entirety and replace with Insurance Specification.

ARTICLE 7 - CONTRACTOR'S RESPONSIBILITIES

SC-7.01 *Contractor's Means and Methods of Construction*

SC-7.01.A Add the following new sentence immediately after the last sentence in 7.01.A:

Nothing in the design, specifications or Contract Documents shall be deemed to constitute a specific means, method, technique, sequence, or procedure of construction. Contractor shall be solely responsible for ensuring that the completed Work conforms accurately to the Contract Documents.

SC-7.05 *"Or-Equals"*

SC-7.05.A Add the following sub-paragraph immediately after Paragraph 7.05.A.1.b.2:

3) the item will be functionally equal to the named item of material or equipment. Contractor warrants and assumes sole responsibility for the adequacy, performance and functioning of the "or-equal" material or equipment.

SC-7.06 *Substitutes*

SC-7.06.A.3.e Add the following sub-paragraph immediately following paragraph 7.06.A.3.d:

e. Contractor warrants that, if approved and incorporated into the Work, the "substitute item" will be functionally

equal to the named item of material or equipment. Contractor assumes sole responsibility for the adequacy, performance and functioning of the "substitute" item of material or equipment.

SC-7.07 *Concerning Subcontractors and Suppliers*

SC-7.07.D Delete Paragraph 7.07.D in its entirety and replace with the following paragraph:

D. No later than two (2) business days after the bid opening, the Contractor shall submit to the Owner and Engineer for acceptance a list of the names and addresses of the Contractor's Subcontractors, Suppliers and such other individuals and entities as the Owner requests.

SC-7.07 Add the following sub-paragraphs immediately following paragraph 7.07.M:

N. Contractor shall require all Subcontractors, prior to commencement of any Work by the Subcontractor, to secure and keep in force the insurance coverages set forth in and required by the Insurance Specification.

O. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors and Suppliers, whether initially or as a replacement, performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions.

SC-7.08 *Patent Fees and Royalties*

SC-7.08.B Delete paragraph 7.08.B in its entirety.

SC-7.11 *Laws and Regulations*

SC-7.11.D Add the following new paragraph immediately after Paragraph 7.11.C:

D. Contractor shall be solely responsible for compliance with all Federal and State Occupational Safety and Health Act ("OSHA") requirements related to the Work and the Site, including, if applicable, the requirements of the Michigan Occupational Safety and Health Act ("MIOSHA"). Neither Owner nor Engineer

shall have any responsibility for construction site safety or OSHA or MIOSHA compliance. Contractor will indemnify and hold harmless Owner and Engineer from all claims, costs, fees, fines, penalties and expenses (including but not limited to all fees and charges of engineers, architects, attorneys and other professionals and all court, administrative proceeding, and dispute resolution costs) related in any way to claims related to construction site safety, OSHA or MIOSHA violations or charges.

SC-7.13 *Safety and Protection*

SC-7.13.A Amend the first sentence of Paragraph 7.13.A to read as follows:

A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work, including but not limited to the enforcement of safety precautions and programs of all Subcontractors.

SC-7.13.D Amend Paragraph 7.13.D to read as follows:

D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense.

SC-7.16 *Submittals*

SC-7.16.B.1 Amend paragraph 7.16.B.1.a to read as follows:

a. Contractor shall submit to Engineer for approval eight (8) copies of all shop drawings.

SC-7.16.B.2 Amend paragraph 7.16.B.2.a to read as follows:

a. Contractor shall submit to Engineer for approval eight (8) duplicates of each Sample.

SC-7.16.E Add the following new paragraph immediately after Paragraph 7.16.E.1.d:

e. Contractor shall submit to Engineer for approval eight (8) duplicates of

each submittal.

SC-7.17 *Contractor's General Warranty and Guarantee*

SC-7.17.A Delete Paragraph 7.17.A in its entirety and replace with the following paragraph:

Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on Contractor's warranty and guarantee. Contractor's warranty and guaranty that all Work will be in accordance with the Contract Documents and will not be defective includes but is not limited to all materials and equipment incorporated into the Work. Unless a longer duration is required by the Project Specifications, Contractor's warranty and guaranty that all Work will be in accordance with the Contract Documents and will not be defective will extend for at least one year after the date of Substantial Completion.

SC-7.17.D.8 Amend paragraph 7.17.D.8 to read as follows:

8. Any inspection, test, review, or approval by Engineer, the Resident Project Representative (if one is assigned to the Site), or by others;

SC-7.17.D.9 Amend Paragraph 7.17.D.9 to read as follows:

9. Any correction of defective Work by Owner; or

SC-7.17.D.10 Add the following new paragraph immediately after Paragraph 7.17.D.9:

10. Any acceptance by Owner, or any failure to do so.

SC-7.19 *Delegation of Professional Design Services*

SC-7.19.B Add the following new sentence immediately after the last sentence in 7.19.B:

The design professional must be licensed in the state or states where the Project is located.

SC-7.19.D Delete Paragraph 7.19.D in its entirety and replace with the following paragraph:

Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, drawings, calculations, specifications, Submittals, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

ARTICLE 9 – OWNER'S RESPONSIBILITIES

SC-9.06 *Insurance*

SC-9.06.A. Delete Paragraph 9.06.A in its entirety and replace with the following paragraph:

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in the Insurance Specifications.

ARTICLE 10 - ENGINEER'S STATUS DURING CONSTRUCTION

SC-10.01 *Owner's Representative*

SC-10.01.A Delete Paragraph 10.01.A in its entirety and insert the following in its place:

A. Engineer will be Owner's representative during the construction period. The Engineer will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents. The authority and responsibilities of the Engineer as set forth in the Contract Documents shall not be restricted, extended or otherwise modified without the written consent of the Engineer and the Owner. Nothing in the Contract Documents shall create for the benefit of the Contractor, any Subcontractor, Supplier or other individual or entity, any contractual relationship between Engineers and any such Contractor, Subcontractor, Supplier or other individual or entity.

SC-10.02 *Visits to Site*

SC-10.02.A Amend Paragraph 10.02.A by striking the following words from the first sentence:

"at intervals appropriate to the various stages of construction"

SC-10.03 *Resident Project Representative*

SC-10.03.C Add the following new paragraphs immediately after Paragraph 10.03.C:

C. If Engineer furnishes a Resident Project Representative (RPR), the RPR will be Engineer's employee or agent at the Site. The RPR's authority and responsibility is expressly limited to making observations of the progress that has been made and the quality of the various aspects of Contractor's executed Work, and reporting same to Engineer. RPR will not be required to make exhaustive or continuous observations or inspections on the Site to check the quality or quantity of the Work. RPR's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. In addition to the limitations set forth in Paragraph 10.07, The RPR does not have the authority or responsibility to:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).

2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.

3. Undertake any of the responsibilities of Contractor, Subcontractors, Suppliers, or Contractor's superintendent.

4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of Contractor's work.

5. Advise on, issue directions regarding, or assume control over safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.

6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.

7. Accept Shop Drawing or Sample submittals.

8. Authorize Owner to occupy the Project in whole or in part.

9. Interpret for Contractor or Owner any provision of the Contract Documents.

10. Stop the Work for any reason.

SC-10.07 *Limitations on Engineer's Authority and Responsibilities.*

SC-10.07.B Add the following sentence immediately after the last sentence in Paragraph 10.07.B:

Engineer may not stop the work or interfere with the progress of the Work. No decision made by the Engineer in good faith either to exercise or not exercise any authority or responsibility delegated to Engineer in the Contract Documents or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall be construed as interference with the progress of the Work. Engineer shall have no authority or responsibility to recommend alternate or possible safety activities or changes for the safety of the project, Contractor, Subcontractors, Suppliers, Owner, employees, third persons or their property.

SC-10.07.F Add the following new paragraph immediately after Paragraph 10.07.E:

F. Engineer will not be responsible for Contractor's failure to pay Subcontractors, Suppliers, employees, taxes, fees, permits, patent fees, copyright fees, royalties, licenses or monies due to any individual or entity.

SC-15.01 *Progress Payments*

SC-15.01.C Delete Paragraph 15.01.C.3.a and insert the following in its place:

a. Inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work; or

SC-15.01.C Delete the period at the end of the sentence in Paragraph 15.01.C.4.e and

insert the following in its place:

, or

SC-15.01.C Add the following new paragraphs immediately after Paragraph 15.01.C.4.e:

f. for Contractor's failure to construct the Work or any part of the Work in conformance with the Contract Documents, or

g. for defective Work.

SC-15.04 *Partial Use or Occupancy*

SC-15.04 Delete Paragraph 15.04.A.4 in its entirety and insert the following in its place:

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of the Insurance Specifications regarding builder's risk or other property insurance.

SC-15.07 *Waiver of Claims*

SC-15.07.A Delete Paragraph 15.07.A in its entirety and insert the following in its place:

A. The making of final payment will not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising (1) from unsettled Liens, (2) from defective Work, (3) from Contractor's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, (4) from outstanding Claims by Owner, (5) from Contractor's continuing obligations under the Contract Documents, and (6) from late completion by Contractor, including without limitation liquidated damages or other damage.

ARTICLE 17 – FINAL RESOULTION OF DISPUTES

SC-17.01 *Methods and Procedures*

SC-17.01.B Delete Paragraph 17.01.B.1 in its entirety and insert the following in its place:

1. At Owner's sole option, Owner may demand in writing arbitration of the dispute;

SC-17.01.C Add the following new paragraph immediately after Paragraph 17.01.B

SC-17.01.C *Arbitration of Claims at Election of Owner*

1. If the Owner elects in writing to demand arbitration as set forth in Paragraph 17.01.1, the dispute will be decided by arbitration in accordance with the rules of the American Arbitration Association in effect as of the Effective Date of the Agreement

2. The demand for arbitration will be filed in writing with the Contractor and with the selected arbitrator, and a copy will be sent to Engineer for information.

3. The award rendered by the arbitrator(s) shall be consistent with the agreement of the parties, in writing, and include: (i) a concise breakdown of the award; and (ii) a written explanation of the award specifically citing the Contract Document provisions deemed applicable and relied on in making the award.

4. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal except as provided by the controlling law governing vacating or modifying an arbitration award.

5. The fees and expenses of the arbitrators and any arbitration service shall be shared equally by Owner and Contractor.

ARTICLE 18 – MISCELLANEOUS

18.01 *Giving Notice*

SC-18.01 Delete Paragraph 18.01.A.3 in its entirety.

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SOIL NOMENCLATURE AND TERMINOLOGY

DRILLING & SAMPLING DESIGNATIONS:

SS : Split Spoon Sample (per ASTM D 1586)
LS : Split Spoon Sample with 3" Liner Insert
ST : Shelby Tube Sample - 3" O.D., unless otherwise noted
AS : Auger Sample
BS : Bulk Sample

HSA : Hollow Stem Auger
SSA : Solid Stem Auger
RB : Rock Bit (NX; BX; AX)
PP : Pocket Penetrometer Value
VS : Vane Shear Value
PM : Pressuremeter test - in situ

STANDARD PENETRATION TEST (ASTM D-1586): A 2-inch OD, 1⅜-inch ID split barrel sampler is driven into undisturbed soil by means of repeating blows from a 140-pound hammer falling 30 inches. The sampler is driven three successive 6-inch increments; the total number of blows required for the final 12 inches of penetration is termed the Standard Penetration Resistance (N).

GRADATION DESCRIPTION & TERMINOLOGY:

Granular Soils (coarse-grained) have more than 50% of their dry weight retained on a #200 sieve; they are described as: *Boulders*, *Cobbles*, *Gravel* or *Sand*. Fine-Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: *Clays* or *Clayey Silts* if they are cohesive, and *Silts* if they are non-cohesive. In addition to gradation, granular soils are defined based on their *in-situ density*; fine grained soils are further defined based on their strength or *consistency*, and on their *plasticity*.

Major Soil Component		Gradation Range
Boulders		Over 12 inches (305mm)
Cobbles		12 inches to 3 inches (305mm to 76mm)
Gravel	Coarse	3 inches to ¾ inches (76mm to 19mm)
	Fine	¾ inches to #4 sieve (19mm to 4.75mm)
Sand	Coarse	#4 sieve to #10 sieve (4.75mm to 2.00mm)
	Medium	#10 sieve to #40 sieve (2.00mm to 0.425mm)
	Fine	#40 sieve to #200 sieve (0.425mm to 0.074mm)
Silt		Passing #200 sieve (0.074mm) to 0.005mm
Clay		Smaller than 0.005mm

Descriptive Term(s) (Of Minor Soil Constituents)	Percent of Dry Weight
Trace	1 - 10
Little	10 - 20
Some	20 - 35
And	35 - 50

CONSISTENCY OF COHESIVE SOILS:

Unconfined Comp Strength, Qu (tsf)	Consistency
<0.25	Very Soft
0.25 – 0.50	Soft
0.50 – 1.00	Medium (firm)
1.00 – 2.00	Stiff
2.00 – 4.00	Very Stiff
4.00 – 8.00	Hard
>8.00	Very Hard

IN-SITU DENSITY OF GRANULAR SOILS:

N - Blows/ft.	In-Situ Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
50 +	Very Dense

WATER LEVEL MEASUREMENT:

Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. It should be noted that groundwater levels observed during drilling in predominantly cohesive soils are not necessarily indicative of the static groundwater level. This is due to the relatively low permeability of clay soils and the tendency of drilling operations to temporarily seal off natural paths of groundwater migration into the borehole. Additionally, fluctuations in groundwater levels should be anticipated with seasonal variations and following periods of heavy or prolonged precipitation.

INSURANCE SPECIFICATIONS

Insurance Required to be Purchased and Maintained by the Contractor

Contractor shall comply with all requirements of this Insurance Specification. Contractor shall purchase and maintain (i.e. keep in force) insurance which conforms to the requirements of this Insurance Specification.

1.1 Insurance—General Provisions

1.1.1 Contractor shall obtain and maintain insurance as required in this Insurance Specification.

1.1.2 All insurance required by the Contract to be purchased and maintained by Contractor shall be obtained from insurance companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue insurance policies for the required limits and coverage's. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

1.1.3 Contractor shall deliver to Owner, with copies to each named insured and additional insured (as identified in this Insurance Specification, in the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Contractor has obtained and is maintaining the policies, coverage's, and endorsements required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

1.1.4 Failure of Owner to demand such certificates or other evidence of the Contractor's full compliance with these insurance requirements, or failure of Owner to identify a deficiency in compliance from the evidence provided, shall not be construed as a waiver of the Contractor's obligation to obtain and maintain such insurance.

1.1.5 If Contractor does not purchase or maintain all of the insurance required of Contractor by the Contract, Contractor shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.

1.1.6 If Contractor has failed to obtain and maintain required insurance, Owner may exclude the Contractor from the Site, impose an appropriate set-off against payment, and exercise Owner's termination rights under Article 16 of the General Conditions of the Contract.

1.1.7 Without prejudice to any other right or remedy, if Contractor has failed to obtain required insurance, Owner may elect to obtain equivalent insurance to protect Owner's interests at the expense of the Contractor, and the Contract Price shall be adjusted accordingly.

1.1.8 Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests.

1.1.9 The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner and other individuals and entities in the Contract.

1.2 Contractor's Insurance - Liability

1.2.1 Owner's & Contractor's Protective Liability: Contractor shall purchase and maintain an Owner's & Contractor's Protective Liability Policy ("OCP" Policy). The OCP policy shall name the Owner, the Engineer, their consultants, agents, and employees, as the insureds (hereinafter collectively called the "named insureds"). The OCP policy will protect the named insureds for any actual or alleged liability arising out of the work performed by the Contractor, the Subcontractor(s), or Suppliers, on this Project. The OCP policy will provide primary, non-contributing coverage.

1.2.2 Workers' Compensation and Employer's Liability: Contractor shall purchase and maintain workers' compensation and employer's liability insurance for:

1.2.2.1 Claims under workers' compensation, disability benefits, and other similar employee benefit acts.

1.2.2.2 United States Longshoreman and Harbor Workers' Compensation Act and Jones Act coverage (if applicable).

1.2.2.3 Claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees (by stop-gap endorsement in monopolist worker's compensation states).

1.2.2.4 Foreign voluntary worker compensation (if applicable).

1.2.3 Commercial General Liability—Claims Covered: Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against:

1.2.3.1 Claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees.

1.2.3.2 Claims for damages insured by reasonably available personal injury liability coverage.

1.2.3.3 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.

1.2.4 **Commercial General Liability—Form and Content**: Contractor's commercial liability policy shall be written on a 1996 (or later) ISO commercial general liability form (occurrence form) and include the following coverage's and endorsements:

1.2.4.1 Products and completed operations coverage: Such insurance shall be maintained for three years after final payment.

1.2.4.2 Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.

1.2.4.3 Blanket contractual liability coverage, to the extent permitted by law, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.

1.2.4.4 Premises/operations liability.

1.2.4.5 Personal and advertising injury.

1.2.4.6 Broad form property damage coverage.

1.2.4.7 Severability of interest (the CGL policy shall apply to each named insured as if that named insured was the only named insured and the policy shall apply separately to each insured against whom claim is made or suit is brought).

1.2.4.8 Underground, explosion, and collapse coverage.

1.2.4.9 Personal injury coverage, including employees (with no exclusions pertaining to employment).

1.2.4.10 Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.

1.2.4.11 For design professional additional insureds, ISO Endorsement CG 20 32 07 04, "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.

1.2.5 **Automobile liability**: Contractor shall purchase and maintain comprehensive automobile liability insurance against claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle, including owned, non-owned, and hired motor vehicles. In light of standard policy provisions concerning (a) loading and unloading, and (b) definitions pertaining to motor vehicles licensed for road use versus unlicensed or self-propelled construction equipment, it is recommended that the comprehensive automobile liability insurance policy and the commercial

general liability policy be written by the same insurance carrier, though not necessarily in one the policy. The comprehensive automobile liability policy shall be written on an occurrence basis.

1.2.6 Umbrella or excess liability: Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, aviation liability and automobile liability insurance described in the paragraphs above and in Section 1.2.10 below. The coverage afforded shall be at least as set for in Section 1.5.6. But if no box is checked in Section 1.5.6, then the umbrella/excess liability coverage limits will be $2,000,000 per occurrence and $2,000,000 general aggregate. The umbrella or excess liability insurance policy(ies) shall be an occurrence policy(ies)

1.2.7 Contractor's pollution liability insurance: Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance shall be maintained for no less than three years after final completion.

1.2.8 Railroad Protective Liability: Contractor shall purchase and maintain a Railroad Protective Liability policy, where such an exposure exists, to provide coverage in the name of each railroad company having jurisdiction over rights-of-way across which Work under the Contract Documents is to be performed. The form of the policy and the limits of liability shall be determined by the railroad company(ies) involved.

1.2.9 Contractor's professional liability insurance: If Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise, then Contractor shall purchase and maintain applicable professional liability insurance. This insurance shall provide protection against claims arising out of performance of professional design or related services, and caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by Contractor itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.

1.2.10 Aviation Liability Insurance: If required on this project as indicated by a check mark in Section 1.5.10, Contractor shall procure and maintain for the duration of the Contract insurance against claims for injuries to persons or damage to property which may arise from or in connection with the ownership, maintenance or use of Manned or Unmanned Aerial Vehicles, including but not limited to drone(s).

1.2.10.1 Minimum Scope and Limit of Insurance: Aviation Liability Insurance on an "occurrence" basis, including products and

completed operations, property damage, bodily injury with limits no less than $1,000,000 per occurrence, and $2,000,000 in the aggregate. This coverage may also be provided by endorsement to the Contractor's Commercial General Liability policy.

1.3 The policies of insurance required to be purchased and maintained by the Contractor shall:

1.3.1 Additional insureds: The Contractor's commercial general liability, automobile liability, umbrella or excess, pollution liability policies and aviation liability insurance, shall include and list as additional insureds the Owner and Engineer, and the following individuals and entities:

Name

The additional insured coverage shall include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and every additional insureds; and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Contractor shall obtain all necessary endorsements to support these requirements. Each additional insured endorsement shall state that each additional insured is entitled to the same rights as the named insured in the event of cancellation, including but not limited to prior notice of cancellation.

1.3.2 Deductible Liability: Any and all deductibles in the polices described in this Insurance Specification shall be assumed by, for the account of, and be the sole responsibility of Contractor. The amount of any deductible is subject to approval by the Owner.

1.3.3 Insurance will be primary: The insurance required to be purchased and maintained by the Contractor under this Insurance Specification shall be primary (i.e. pay first) as respects any insurance, self-insurance or self-retention maintained by the Owner, Engineer, and any other insureds. Any insurance, self-insurance or self-retention maintained by the Owner, Engineer, or any other insureds, shall be in excess of the insurance purchased and maintained by the Contractor under this Insurance Specification, and shall not contribute with it.

1.3.4 Coverages: Include at least the specific coverage's provided in this Insurance Specification.

1.3.5 **Minimum Limits:** Be written for not less than the limits of liability provided in this Insurance Specification and in the Supplementary Conditions, or required by Laws or Regulations, whichever is greater.

1.3.6 **Notice of Cancellation:** Contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least ten (10) days prior written notice has been given to Contractor. Within three (3) days of receipt of any such written notice, Contractor shall provide a copy of the notice to Owner, Engineer, and each other insured under the policy.

1.3.7 **Duration:** Remain in effect at least until final payment (and longer if expressly required in this Insurance Specification or the Supplementary Conditions) and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract Documents.

1.3.8 Be appropriate for the Work being performed and provide protection to Contractor, Owner, Engineer, and any other additional insured, from claims that may arise out of or result from Contractor's, Sub-contractor's or Supplier's performance of the Work, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.

1.3.9 The coverage requirements for specific policies of insurance must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

1.4 Contractor's Insurance - Property

1.4.1 **Builder's Risk**: If required on this project as indicated by a check mark in Section 1.5.7, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the full insurable replacement cost thereof (subject to such deductible amounts as may be provided in this Insurance Specification, or the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1.4.1.1 Include the interests of Owner, Contractor, Subcontractors, Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors, of any of them, and any other individuals or entities required by this Insurance Specification and/or the Supplementary Conditions to be insured under such builder's risk policy. Each of whom shall be listed as a named insured (the parties required to be insured shall collectively be referred to as "insureds").

1.4.1.2 Be written on a builder's risk "all risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or

causes of loss: fire; lightning; windstorm; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; flood; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; water damage (other than that caused by flood); and such other perils or causes of loss as may be specifically required by this Insurance Specification and/or the Supplementary Conditions. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise, such insurance may be provided through other insurance policies acceptable to Owner and Contractor.

1.4.1.3 Cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.

1.4.1.4 Cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects).

1.4.1.5 Extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier).

1.4.1.6 Extend to cover damage or loss to insured property while in transit.

1.4.1.7 Allow for partial occupation or use of the Work by Owner, such that those portions of the Work that are not yet occupied or used by Owner shall remain covered by the builder's risk insurance.

1.4.1.8 Allow for the waiver of the insurer's subrogation rights, as set forth below.

1.4.1.9 Provide primary coverage for all losses and damages caused by the perils or causes of loss covered.

1.4.1.10 Not include a co-insurance clause.

1.4.1.11 Include an exception for ensuing losses from physical damage or loss with respect to any defective workmanship, design, or materials exclusions.

1.4.1.12 Include performance/hot testing and start-up.

1.4.1.13 Be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer, with 30 days written notice to each other Insured.

1.4.2 Notice of Cancellation or Change: All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this section shall contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least ten (10) days prior written notice has been given to the purchasing policyholder. Within three (3) days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured.

1.4.3 Deductibles: Contractor shall pay for costs not covered because of the application of a policy deductible.

1.4.4 Partial Occupancy or Use by Owner: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 15.04 of the General Conditions of the Contract, then Owner, through Contractor, will provide notice of such occupancy or use to the builder's risk insurer. The builder's risk insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy; rather, those portions of the Work that are occupied or used by Owner may come off the builder's risk policy, while those portions of the Work not yet occupied or used by Owner shall remain covered by the builder's risk insurance.

1.4.5 Additional Insurance: If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this section, it may do so at Contractor's expense.

1.4.6 Insurance of Other Property: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, such as tools, construction equipment, or other personal property owned by Contractor, a Subcontractor, or an employee of Contractor or a Subcontractor, then the entity or individual owning such property item will be responsible for deciding whether to insure it, and if so in what amount.

1.4.7 Waiver of Rights: All policies purchased in accordance with this Section 1.4, expressly including the builder's risk policy, shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights

of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all Subcontractors, all individuals or entities identified in this Insurance Specification, or the Supplementary Conditions as insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.

1.4.8 Sub-Contractors Waiver of Rights: Contractor shall be responsible for assuring that the agreement under which a Subcontractor performs a portion of the Work contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in this Insurance Specification or the Supplementary Conditions, as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by builder's risk insurance and any other property insurance applicable to the Work.

1.4.9 Receipt and Application of Property Insurance Proceeds: Any insured loss under the builder's risk and other policies of insurance required by this section will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by this section shall distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of the Contract or applicable Laws and Regulations.

If no other special agreement is reached, the damaged Work shall be repaired or replaced, the money so received applied on account thereof, and the Work and the cost thereof covered by Change Order, if needed.

1.5 Minimum limits

1.5.1 The minimum limits for the insurance required by this Insurance Specification shall provide coverage for not less than the following amounts or greater where required by Laws or Regulations:

1.5.2 Owner's & Contractor's Protective Liability Policy

1.5.2.1	Each Occurrence	$1,000,000
1.5.2.2	General – Aggregate	$2,000,000

1.5.3 Contractor's Commercial General Liability Policy

1.5.3.1	General – Aggregate	$2,000,000
1.5.3.2	Products – Completed Operations Aggregate	$2,000,000
1.5.3.3	Personal and Advertising Injury	$1,000,000
1.5.3.4	Each Occurrence	$1,000,000
1.5.3.5	Fire damage	$50,000
1.5.3.6	Medical Expense	$5,000

1.5.4 Comprehensive Automobile Liability Policy (In accordance with Michigan's No Fault Statute)

1.5.4.1	Combined Single Limit of	$1,000,000

1.5.5 Worker's Compensation and Employer's Liability Policy

1.5.5.1	Michigan		Statutory Limits
1.5.5.2	Employer's Liability		
	1.5.5.2.1	Each accident	$ 500,000
	1.5.5.2.2	Disease – each employee	$ 500,000
	1.5.5.2.3	Disease – policy limit	$ 500,000
1.5.5.3	Federal, if applicable (e.g. FELA, Longshoreman's, etc. . . .)		Statutory Limits

1.5.6 Excess or Umbrella Liability Policy

Unless increased limits are required as checked below, the limits shall be:

1.5.6.1	General Aggregate	$2,000,000
1.5.6.2	Each Occurrence	$2,000,000

Owner may select increased limits for this project as checked below; otherwise, the above limits shall apply if neither below option is checked:

	Option One	☐ Check if required	
	1.5.6.1	General Aggregate	$5,000,000
	1.5.6.2	Each Occurrence	$5,000,000
	Option Two	☐ Check if required	
	1.5.6.1	General Aggregate	$10,000,000
	1.5.6.2	Each Occurrence	$10,000,000
1.5.7	Builder's Risk "all risk" policy		Full Replacement Cost
	☐ Check if required		
	Items to be covered by Builder's Risk include:		
	(not required)		
1.5.8	Contractor's Pollution Liability Policy		$1,000,000
1.5.9	Railroad Protective Liability		
	☐ Check if required		$
1.5.10	Aviation Liability Insurance		
	☐ Check if required		
	1.5.10.1	General – Aggregate	$2,000,000
	1.5.10.2	Products – Completed Operations Aggregate	$2,000,000
	1.5.10.4	Each Occurrence	$1,000,000
1.5.11	Other insurance	☐ Check if required (List Type)	$

OP ID: JF

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER - - - - Phone: Fax:	CONTACT NAME: PHONE (A/C, No, Ext): FAX (A/C, No): E-MAIL ADDRESS: PRODUCER CUSTOMER ID #: _
INSURED Owner's Name and Address - -	INSURER(S) AFFORDING COVERAGE — NAIC # INSURER A : INSURANCE COMPANY _ AM BEST FINANCIAL INSURER B : INSURER C : INSURER D : INSURER E : INSURER F :

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
-- - - -	**GENERAL LIABILITY** COMMERCIAL GENERAL LIABILITY CLAIMS-MADE OCCUR X Owner's & Contractor's Prot GEN'L AGGREGATE LIMIT APPLIES PER: POLICY PRO-JECT LOC						EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$ 1,000,000 $ $ $ $ 2,000,000 $
	AUTOMOBILE LIABILITY ANY AUTO ALL OWNED AUTOS SCHEDULED AUTOS HIRED AUTOS NON-OWNED AUTOS						COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident)	$ $ $ $
	UMBRELLA LIAB OCCUR **EXCESS LIAB** CLAIMS-MADE DEDUCTIBLE RETENTION $						EACH OCCURRENCE AGGREGATE	$ $
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y / N ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? **(Mandatory in NH)** If yes, describe under DESCRIPTION OF OPERATIONS below	N / A					WC STATU-TORY LIMITS OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	$ $ $

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

CERTIFICATE HOLDER

-

Contractor's Name and Address

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

OP ID: JF

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)

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IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER - - - - Phone: Fax:	CONTACT NAME: PHONE (A/C, No, Ext): FAX (A/C, No): E-MAIL ADDRESS: PRODUCER CUSTOMER ID #: _
INSURED Contractor's Name and Address - -	INSURER(S) AFFORDING COVERAGE — NAIC # INSURER A : INSURANCE COMPANY _ AM BEST FINANCIAL INSURER B : INSURER C : INSURER D : INSURER E : INSURER F :

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
-	**GENERAL LIABILITY** X- COMMERCIAL GENERAL LIABILITY [ ] CLAIMS-MADE [X] OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: [ ] POLICY [X] PRO-JECT [ ] LOC						EACH OCCURRENCE DAMAGE TO RENTED PREMISES (Ea occurrence) MED EXP (Any one person) PERSONAL & ADV INJURY GENERAL AGGREGATE PRODUCTS - COMP/OP AGG	$ 1,000,000 $ 100,000 $ 5,000 $ 1,000,000 $ 2,000,000 $ 2,000,000
-	**AUTOMOBILE LIABILITY** X ANY AUTO X ALL OWNED AUTOS X SCHEDULED AUTOS X HIRED AUTOS X NON-OWNED AUTOS						COMBINED SINGLE LIMIT (Ea accident) BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident)	$ 1,000,000 $ $ $
-	X **UMBRELLA LIAB** X OCCUR **EXCESS LIAB** [ ] CLAIMS-MADE DEDUCTIBLE RETENTION $						EACH OCCURRENCE AGGREGATE	$ 2,000,000 $ 2,000,000
-	**WORKERS COMPENSATION AND EMPLOYERS' LIABILITY** ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? Y / N [ ] **(Mandatory in NH)** If yes, describe under DESCRIPTION OF OPERATIONS below	N / A					X WC STATU-TORY LIMITS [ ] OTH-ER E.L. EACH ACCIDENT E.L. DISEASE - EA EMPLOYEE E.L. DISEASE - POLICY LIMIT	$ 500,000 $ 500,000 $ 500,000
-	**Builder's Risk "ALL RISK" PROPERTY** **POLLUTION LIABILITY**						**CONTENTS**	**Full Replacement Cost** **$1,000,000**

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

Name of Additional Insured

CERTIFICATE HOLDER

-

Owner's Name and Address

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

[Intentionally left blank]

SPECIAL NOTICE
CONTRACT ADMINISTRATION

Any reference herein to the Michigan Department of Commerce or the Michigan Department of State Highways and Transportation shall be deemed to be referenced to the Michigan Department of Transportation.

The Gerald R. Ford International Airport Authority will administer this Contract. Any reference to the Michigan Department of Transportation or Michigan Aeronautics Commission or Bureau of Aeronautics in the Contract Documents in regard to any administrative function shall be taken to mean the Gerald R. Ford International Airport Authority.

END OF NOTICE

Project Specifications

Owner:	Gerald R. Ford International Airport Authority, Kent County, Michigan
Project Title:	C-418 Viewing Park Expansion
Project #:	2240980

I. GENERAL

1. CONTRACT PROVISIONS – SUBCONTRACTING OF CONTRACT WORK

   The Contractor shall provide copies of all subcontracts to the Project Engineer. The Contractor shall perform, with his/her organization, an amount of work equal to at least twenty-five percent (25%) of the total contract cost.

2. SPECIFICATIONS

   Unless otherwise specified in the Plans or Specifications, all construction shall be performed in accordance with 2020 MDOT Standard Specifications, Standard Plans and Special Details (English units), and Special Provisions as modified and amplified by these project specifications and the construction plans.

   The General Conditions, Supplementary Conditions, Insurance Specifications and Project Specifications, including Appendices, of this contract shall supersede any conflicting provisions in the referenced standard specifications.

3. MATERIALS AND TESTING

   The Owner reserves the right to sample and test any of the materials required for the proposed construction, either before or after delivery to the project, and to reject any material represented by any sample which fails to comply with the minimum requirements specified. The Contractor shall furnish all materials reasonably required for sampling, testing and analysis necessary for the testing of materials as required by these specifications.

   HMA testing will be completed according to MDOT Special Provision 20SP-501I-01. Concrete testing will be per MDOT 2020 specifications.

   Contractor shall perform concrete testing in accordance with MDOT standards. Concrete testing shall include temperature, slump, air, and compressive strength testing, including not less than four (4) test cylinders from each day's pour, as directed by the Engineer, and submit test results. The Contractor shall certify in writing that all materials meet MDOT specifications and shall provide copies of all test reports.

4. CONSTRUCTION STAKING

   The Contractor shall perform all construction staking. Electronic copies of the AutoCAD base drawings and digital terrain model (DTM) will be provided upon receipt of a signed

waiver. Owner will provide field identification of benchmarks and control points as shown on the plans.

Any irregularity in grade, line or the digital terrain model discovered by the contractor shall be reported to the Engineer for correction before proceeding with the work.

The contractor shall provide such additional methods, materials, or equipment as may be necessary to facilitate laying out, inspecting and constructing the work. The contractor shall assume full responsibility for all detailed dimensions and elevations measured from the lines, grades and elevations established by the Engineer.

The construction stakes shall be left in place until each phase of the work has been completed and inspected. In the event there are discrepancies in the location or grade of the work, the contractor shall be responsible for making the necessary corrections unless grade stakes that show evidence of an error in staking are left in place.

5. DUST CONTROL

All haul roads, airport pavement and other public and private roads (including backfilled trenches), driveways and parking lots used by the Contractor must be maintained in a dust free condition during the life of this Contract. The control of dust shall be accomplished by sweeping and by the application of dust control materials.

Cost of providing dust control shall be included in the major items of construction.

Should the Contractor be negligent in his duties in providing dust control, the Owner shall take the necessary steps to perform such work and will charge the Contractor for all costs. Failure to respond as specified may also be cause for the suspension of progress payments until compliance is achieved.

6. PROTECTION OF WORK

The Contractor shall protect the work until it is accepted by the Engineer. Any part of the completed work that is damaged prior to acceptance by the Engineer shall be replaced at the Contractor's expense.

II. DEMOLITION

1. TREE REMOVAL

Tree removal will be in accordance with Section 202 of the 2020 MDOT Standard Specifications for Construction.

III. EXCAVATION AND EMBANKMENT

1. ROADWAY EARTHWORK

Excavation and embankment will be in accordance with Section 205 of the 2020 MDOT Standard Specifications for Construction.

IV. SOIL EROSION AND SEDIMENTATION CONTROL

1. SOIL EROSION AND SEDIMENTATION CONTROL

   Soil erosion and sedimentation control will be in accordance with Section 208 of the 2020 MDOT Standard Specifications for Construction and MDOT Standard Detail R-96-E.

V. BASES

1. SUBBASE

   Subbase will be in accordance with Section 301 of the 2020 MDOT Standard Specifications for Construction. Subbase material will be MDOT CL II.

2. AGGREGATE BASE

   Aggregate base course will be in accordance with Section 302 of the 2020 MDOT Standard Specifications for Construction. Aggregate base will be MDOT 21AA.

3. AGGREGATE SURFACE

   Aggregate surface courses will be in accordance with Section 306 of the 2020 MDOT Standard Specifications for Construction. Aggregate surface will be MDOT 21AA.

VI. DRAINAGE FEATURES

1. PIPE CULVERTS

   Pipe culverts will be in accordance with Section 401 of the 2020 MDOT Standard Specifications for Construction and MDOT Standard Details R-82-D and R-86-F.

2. STORM SEWERS

   Storm sewers will be in accordance with Section 402 of the 2020 MDOT Standard Specifications for Construction and MDOT Standard Detail R-83-C.

3. DRAINAGE STRUCTURES

   Drainage structures will be in accordance with Section 403 of the 2020 MDOT Standard Specifications for Construction and MDOT Standard Details R-01-G and R-10-D.

4. UNDERDRAINS

Underdrain will be in accordance with Section 404 of the 2020 MDOT Standard Specifications for Construction.

VII. HOT MIX ASPHALT

1. HOT MIX ASPHALT

   Hot mix asphalt will be in accordance with Section 501 of the 2020 MDOT Standard Specifications for Construction and the following MDOT Special Provisions:
   - 20SP-501A-01
   - 20SP-501C-01
   - 20SP-501F-01
   - 20SP-501I-01

2. MIX DESIGN

   The Contractor shall provide a current MDOT mix design for materials to be used on this project which shall be approved by the Engineer prior to use.

VIII. CONCRETE CURB, GUTTER AND SIDEWALK

1. CONCRETE CURB AND GUTTER

   Concrete curb and gutter will be in accordance with Section 802 of the 2020 MDOT Standard Specifications for Construction.

2. CONCRETE SIDEWALK

   Concrete sidewalk will be in accordance with Section 803 of the 2020 MDOT Standard Specifications for Construction and MDOT Standard Detail R-28-K.

3. CONCRETE PARKING RAIL

   Concrete parking rails will be in accordance with Section 807 of the 2020 MDOT Standard Specifications for Construction and MDOT Standard Detail R-74-D.

IX. FENCING

1. CHAIN LINK FENCE AND GATES

   Chain link gates will be in accordance with Section 808 of the 2020 MDOT Standard Specifications for Construction.

X. SIGNAGE AND MARKING

1. SIGNAGE

   Signage will be in accordance with Section 810 of the 2020 MDOT Standard Specifications for Construction and the details included in the drawings.

2. PAVEMENT MARKING

   Pavement markings will be in accordance with Section 811 of the 2020 MDOT Standard Specifications for Construction.

XI. SLOPE PROTECTION AND RESTORATION

1. SLOPE PROTECTION

   Riprap will be in accordance with Section 813 of the 2020 MDOT Standard Specifications for Construction.

2. TURF ESTABLISHMENT

   Topsoil, seed, fertilizer, and mulch will be in accordance with Section 816 of the 2020 MDOT Standard Specifications for Construction.

XII. ELECTRICAL

1. ELECTRICAL CONDUIT

   Conduit will be in accordance with Sections 818 and 918 of the 2020 MDOT Standard Specifications for Construction. Conduit types and sizes are to be in accordance with the drawings.

2. EQUIPMENT GROUNDING AND BONDING

   Equipment grounding and bonding will be in accordance with Sections 818 and 918 of the 2020 MDOT Standard Specifications for Construction. Grounding is to be in accordance with the drawings and the National Electric Code (NEC).

3. WIRE AND CABLE

   Wire and cable will be in accordance with Sections 818 and 918 of the 2020 MDOT Standard Specifications for Construction. Wire type and size is to be in accordance with the drawings.

4. HANDHOLES

   Handholes will be in accordance with Sections 818 and 918 of the 2020 MDOT Standard Specifications for Construction. Size is to be in accordance with the drawings.

5. ELECTRICAL SERVICE

Electrical service will be in accordance with Sections 804, 818 and 918 of the 2020 MDOT Standard Specifications for Construction. Requirements are to be in accordance with the drawings.

6. RECEPTACLE PEDESTAL

Food truck receptacle pedestal materials will be in accordance with Sections 804, 818 and 918 of the 2020 MDOT Standard Specifications for Construction. This item includes the Pedestal mounted receptacle, protection bollards, and concrete encasement as shown on the drawings. Receptacle shall be capable of being pad locked when in use or when not in use and shall accommodate extension cord “grip handle”.

Section 202. Removing Trees, Stumps, and Corduroy

202.01. Description

This work consists of removing trees and stumps with a diameter of at least 6 inches located outside the clearing limits and removing corduroy within the limits of the proposed roadbed and backfilling as required.

202.02. Material

Provide materials in accordance with the following:

Sound Earth 205
Granular Material Class III 902

202.03. Construction

A. **Removing Trees or Stumps.** Remove and dispose of trees or stumps with a diameter of at least 6 inches that are outside the clearing limits. Remove non-ornamental fruit trees within the right-of-way even if not shown on the plans. Remove and dispose of trees, stumps, roots, and debris in accordance with section 201.

If removing a stump could result in damage to existing utilities, remove the stump by chipping it to a depth of at least 12 inches below the finished ground surface. Remove other stumps by chipping only if approved by the Engineer. Backfill removal areas with granular material Class III within the influence of the subgrade surface and sound earth outside the influence of the subgrade surface.

B. **Removing Corduroy.** Remove and dispose of logs, poles, stumps, brush, and other material embedded under the surface of an abandoned or existing road within the limits of the proposed roadbed. Remove corduroy in the roadbed if within 4 feet of the plan grade. Dispose of corduroy in accordance with section 201. Backfill trenches excavated after the removal of corduroy with granular material Class III.

202.04. Measurement and Payment

Pay Item	Pay Unit
Tree, Rem, __ inch to __ inch	Each
Stump, Rem, __ inch to __ inch	Each
Tree, Rem, 37 inch or Larger	Each
Stump, Rem, 37 inch or Larger	Each
Corduroy, Rem	Station

A. **Trees and Stumps.** The Engineer will determine the size of trees by the diameter of the trunk measured to the nearest full inch 4½ feet above the ground line at the base of the tree. The Engineer will measure trees with

major limbs lower than 4½ feet from the ground at the smallest diameter below the limbs.

The cost of removing trees or stumps with a diameter of less than 6 inches is included in other pay items.

Where more than one trunk has grown from a common stump, the Engineer will measure each trunk as a separate tree.

The Engineer will measure stump diameters to the nearest full inch at the top of the stump.

For stumps incorrectly shown on the plans as trees designated for removal, the Engineer will measure, and the Department will pay for, removing stumps with the relevant stump removal pay item. If the contract does not include stump removal pay items but includes tree removal pay items, the Department will pay for removing stumps with the relevant tree removal pay item.

The unit price for tree and stump removal pay items includes the cost of providing and placing backfill. Tree removal pay items include respective stump removal.

B. **Corduroy, Removal.** The Engineer will measure **Corduroy, Rem** along the road centerline. The unit price for **Corduroy, Rem** includes the cost of backfill. The Department will apply **Corduroy, Rem** if below the excavation limits required for other pay items.

Section 205. Roadway Earthwork

205.01. Description

This work consists of the following:

A. Constructing earth grades by excavating soil or rock and placing embankments or fills;

B. Salvaging and stockpiling selected materials;

C. Providing, placing, and compacting embankment materials;

D. Trimming the earth grade;

E. Disposing of surplus or unsuitable material; and

F. Maintaining the work in a finished condition until accepted by the Engineer.

Earth excavation consists of the work to excavate materials not otherwise addressed in the contract as separate work items. Rock excavation and subgrade undercutting are separate work items.

Investigate local conditions before bidding in accordance with subsection 102.04. Boring logs shown on the plans are for information only. Refer to MDOT's *Geotechnical Manual* for detailed data on soils.

G. **Definitions**

CIP. When used with an embankment item, CIP denotes compacted-in-place.

Frost heave textured material. Material with more than 50% silt particles by weight and a plasticity index of less than 10.

Loose measure (LM). Refer to section 109.01.B.2.

Silt. Material with a particle size from 0.002 mm to 0.075 mm.

Sound earth. Natural homogeneous material composed of soil or aggregate that can be compacted to the required density, contains no visible organic material, and has a maximum unit weight of at least 95 pounds per cubic foot.

205.02. Materials

Provide materials in accordance with the following sections:

Do not use foundry sand from metal casting for roadway earthwork.

Refer to MDOT's *Density Testing and Inspection Manual* for maximum unit weight and in-place density test methods.

205.03. Construction

Before beginning earth-disturbing activities, install soil erosion and sedimentation control measures in accordance with section 208.

The Department considers buried rubbish and trash not identified in the contract a differing site condition in accordance with subsection 103.02.C. All buried rubbish and trash that are found must be disposed of properly.

A. **Preparing Roadway Foundation.** Remove material from the roadway foundation and salvage or dispose of. Compact the roadway foundation to the depth and density required.

Perform removal, salvage, and disposal operations in accordance with the following:

1. **Removing and Salvaging Topsoil.** Before removing topsoil, reduce vegetation to a height of 6 inches. Remove and dispose of cut vegetation, brush, rocks, and other unsuitable material.

   Remove topsoil to the required depth from designated areas before excavating or placing embankment. Use equipment and methods that avoid lifting subsoil. Suspend topsoil removal if the Engineer determines that soil or weather conditions are unsuitable.

   Submit a request to the Engineer in accordance with subsection 104.12 to temporarily stockpile topsoil inside the right-of-way.

   Prior to temporarily stockpiling topsoil outside the right-of-way, obtain written permission from the owner of the property that has been designated for material placement and obtain required permits in accordance with subsection 208.03.A. Provide documentation to the Engineer before stockpiling topsoil. Do not stockpile temporarily or permanently in wetlands or floodplains.

   Remove topsoil as follows:

   a. In peat and muck areas, do not remove topsoil;

   b. In borrow and clear vision areas, remove topsoil to the depth and width required;

   c. At inlet, outlet, and berm ditch areas, remove topsoil within the construction limits; and

   d. At roadway cut and embankment areas, remove topsoil within the limits of earth disturbance.

2. **Salvaging Materials.** Remove existing gravel, crushed stone, or selected excavated materials. The Contractor may salvage these materials. The Engineer may approve the use of salvaged materials to construct earth shoulders, approaches, or temporary roadway surfacing or to use in other work the Engineer determines appropriate. Do not salvage foreign or undesirable material. Temporarily stockpile salvaged material outside the limits of Contractor's earth disturbance and within the right-of-way limits, as approved by the Engineer.

   Surplus salvaged material is the property of the Contractor. Dispose of surplus salvaged materials in accordance with subsection 205.03.P before project completion.

3. **Disposing of Stones, Broken Rock, and Boulders**. For materials that cannot be incorporated in the work, dispose of the materials in accordance with subsection 205.03.P.

B. **Rock Excavation.** Excavate boulders with a volume of at least ½ cubic yard. Excavate rock or cemented soils that do not soften when wet or that cannot be removed without continuous drilling, blasting, or continuous use of a ripper or other special equipment.

   Expose the surface of the rock to allow the Engineer to measure before starting rock excavation. Remove rock encountered in the excavation to the required cross section and in accordance with all of the following:

   1. Excavate so no rock extends more than 6 inches above the lines of the required cross section;

   2. Excavate backslopes to the neat line slopes shown on the plans with no rock extending more than 12 inches from the true slope;

   3. Excavate the rock surface to provide drainage. Do not leave undrained pockets in the rock surface; and

   4. Remove rock or boulders loosened in the excavation and overhanging ledges on or outside the required cross section.

C. **Peat Excavation.** Remove peat, muck, marl, and very soft underlying clay. Coordinate removal with swamp backfill operations.

D. **Swamp Backfill.** Construct embankments across peat marshes as shown on the plans. Widen the embankment at culvert locations to provide a stable foundation for the length of the culvert, including headwalls and end sections. Provide granular material Class III for swamp backfill.

   If total excavation of peat results in a reasonably dry trench as determined by the Engineer, the Engineer may allow backfilling as a separate operation. Backfill the reasonably dry trench immediately after completing

the excavation in accordance with the controlled density method in subsection 205.03.H.4.a. Perform excavation and backfill as separate operations in shallow peat areas only with the Engineer's prior approval.

Coordinate the rate of advancement of the embankment and surcharge in deep swamps with the rate of excavation of the upheaved peat. If a trench of the required depth is not maintained full width ahead of the surcharge, use additional peat-excavating equipment or stop construction of embankment and surcharge until the two operations are in balance.

Dispose of peat as shown on the plans or in accordance with subsection 205.03.P.

The Department will bore swamp backfill to determine whether unsuitable material has been completely excavated or displaced. If the borings show the presence of unsuitable material under the swamp backfill, the Department will determine the corrective action. The Department will complete borings and notify the Contractor of corrective actions within 60 days after completion of the swamp backfill.

Corrective action may consist of excavating, placing a surcharge, excavating relief trenches, or a combination of these actions.

If a surcharge is placed over the swamp backfill, the Engineer will determine the width and elevation. Leave the surcharge in place until the Engineer determines that the swamp backfill is stable or the required settlement has taken place. The Engineer may require that the surcharge remain in place for up to 90 days.

Material from the surcharge is the property of the Contractor.

Obtain the Engineer's approval for swamp backfill and complete peat excavation and spreading before placing the pavement structure.

E. **Subgrade Undercutting.** Undercut the subgrade and backfill to replace material susceptible to frost heaving or differential frost action and to remedy unstable soil conditions.

Topsoil removal and peat excavation are not included in subgrade undercutting. Subgrade undercutting includes excavation below subgrade in cut sections, excavation at the transition from cut-to-fill sections, and excavation, other than peat excavation, as required below the topsoil in fill sections.

Excavated material from subgrade undercutting is the property of the Contractor.

1. **Limits of Subgrade Undercutting.** Excavate the subgrade to the approximate grade. The Engineer will promptly inspect the grade to

decide whether undercutting is necessary and to determine the limits of undercutting.

In shallow fill areas, the Engineer will inspect the fill area and determine the limits of the subgrade undercutting before the Contractor begins embankment placement.

Remove deposits of frost heave textured material within the subgrade surface limit. For areas north of the north boundary of Township 12 North, remove the frost heave textured material to a depth of 4 feet to 5 feet below the plan grade. For areas south of the north boundary of Township 12 North, remove the frost heave textured material to a depth of 3½ feet to 4 feet below the plan grade.

2. **Backfill of Subgrade Undercut.** Backfill subgrade undercutting Type I with selected clay or other Engineer-approved material.

   Backfill subgrade undercutting Type II with granular material Class II.

   Backfill subgrade undercutting Type III with the material excavated from subgrade undercut areas after mixing the excavated material to break up the undesirable strata of soils or with other Engineer-approved backfill material.

   Backfill subgrade undercutting Type IV with 21AA dense-graded aggregate or 4G open-graded aggregate. Encapsulate 4G aggregate with geotextile separator.

   Compact subgrade undercutting backfill to at least 95% of its maximum unit weight.

F. **Subgrade Manipulation.** Scarify, mix, and blend the roadbed subgrade to a depth of 12 inches below the top of subgrade. Compact to at least 95% of its maximum unit weight.

G. **Earth Excavation.** Excavated material is the property of the Contractor.

Compact the subgrade to at least 95% of its maximum unit weight and to a depth of at least 10 inches. If the subgrade cannot be compacted to 95% of its maximum unit weight using conventional construction methods, the Engineer may authorize the use of other methods to attain compaction.

In cut sections where the existing material appears to meet the requirements of subsection 301.02, excavate the grade to top of subbase rather than to the bottom of subbase. The Engineer will then determine whether the existing material meets subbase requirements. Shape material meeting subbase requirements to the top of subbase grade and compact to at least 95% of its maximum unit weight and to a depth of at

least 12 inches. The Engineer will adjust earthwork quantities accordingly. Excavate material not meeting subbase requirements to the bottom of subbase. The Department will not consider claims for damage caused by the Contractor's halting of grading operations so the Engineer can make subbase determinations.

Maintain the roadbed and ditches and provide drainage at all times. Install and remove temporary drainage facilities at no additional cost to the Department.

Perform grading to avoid removing or loosening material outside the required slopes. Replace and compact material removed or loosened outside the slopes to the required density and cross section.

Dispose of surplus or waste material resulting from ditch construction in accordance with subsection 205.03.P. Remove roots, stumps, or other materials that are unacceptable to the Engineer in the slopes and bottom of the ditch and backfill the holes with suitable material. Maintain ditches until the Engineer's final acceptance.

H. **Roadway Embankment**

1. **Stepping Side Slope**. Step embankments constructed on existing side slopes of 1:6 or steeper before placing embankment. Form steps with a horizontal dimension of at least 3 feet according to the *MDOT Standard Plan R-105* series.

2. **Borrow.** Borrow is defined in subsection 105.03. Excavate, transport, and place borrow material in accordance with subsection 105.03 and the following:

   After removal of borrow, leave borrow areas free formed without rigid geometric shapes. Make side slopes as flat as practical but ensure that slopes are no steeper than 1:4. Round the tops and bottoms of slopes with vertical curves to blend into adjacent terrain. Grade overburden left in the borrow area, except topsoil, to eliminate unsightly mounds, as determined by the Engineer.

   Where practical, shape borrow areas to drain, leaving usable land after completion. In granular soil, leave the area at least 12 inches above the high ground water level. In cohesive soil, leave the area at least 12 inches above the high-water elevation of the drainage outlet.

   If the borrow area cannot be drained, create a pond or a wetland. Create ponds by excavating to a depth of at least 8 feet below normal ground water level in granular soil or to 8 feet below the lowest drainage outlet in cohesive soil. Create wetlands by excavation to the elevation directed by the Engineer.

Restore borrow areas as shown on the plans or in a manner that will leave the land in a useful condition and with a natural appearance. Restore borrow areas within the right-of-way as required by the contract. Fence ponded borrow areas unless otherwise directed by the Engineer.

Restore borrow areas outside the right-of-way in accordance with permit requirements covered by Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act (MCL 324.9101 et seq.) and any land use agreements with the property owner.

The Engineer may allow boulders to remain in borrow areas if placement creates a natural appearance.

The Engineer may waive restoration requirements if the Contractor takes borrow from the working area of an existing commercial source or the property owner holds a permit from a county or municipal enforcing agency designated under Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act (MCL 324.9101 et seq.) Provide the Engineer with a copy of the property owner's permit.

3. **Winter Grading.** The Engineer will determine the winter grading limits. Remove ice and snow from the ground surface before placing embankment.

   Remove frozen material if the original ground contains more than 4 inches of frost within the limits of 1:1 slopes extending away from the finished shoulders to points of intersection with the original ground.

   Remove frozen material on a partially complete fill before placing more fill on the embankment. Stockpile frozen material in areas approved by the Engineer and outside the limits of earth disturbance until thawed. Use the thawed material in the embankment if it meets moisture requirements at the time of use.

4. **Placing and Compacting Embankment.** After preparing the ground area, construct embankments with sound earth and stones, broken rock, concrete, or masonry, except within the top 3 feet of embankment, or as allowed in the disposal of peat excavation material in accordance with subsection 205.03.D and subsection 205.03.P. Do not place frost heave textured materials in the top 3 feet of embankment below subgrade surface. Use a uniformly textured material to construct the top 3 feet of embankment to a uniformly

stable condition. Provide at least 50 feet of longitudinal transition between two types of textured materials.

Deposit embankment materials and compact in accordance with the controlled density method. The Engineer may direct or approve the 12-inch layer method, rock embankment method, or methods for the treatment of peat marshes.

Construct embankments using methods that do not create an unstable slope condition. Do not block the drainage of granular material by placing impervious material on the outside of embankments or by placing a combination of pervious and impervious material in the embankment, creating potential pockets of saturated material. Do not place peat excavation material in upland areas between the 1:1 slope that extends down from the subgrade surface/front slope intercept point and the final plan fill slope in fills greater than 14 feet high.

The Engineer may allow the placement of uncovered stones within construction limits, broken concrete, and broken rock from rock cuts in embankments. Use stones, broken concrete, and broken rock with the largest dimension no greater than 12 inches. Place in layers. Fill voids with sound earth and compact to at least 95% maximum unit weight. Do not place stones, broken concrete, or broken rock layers within 3 feet of the subgrade surface.

When placing embankment in layers of the required thickness is not feasible (e.g., filling in water, constructing on poorly drained soil), the Engineer may allow construction of the embankment in one layer of granular material Class III and will determine the minimum elevation for equipment operation. Thoroughly compact the fill material. Above the granular material Class III elevation, construct the embankment in accordance with the controlled density method.

Backfill and compact embankment adjacent to structures in accordance with subsections 205.03.I and 206.03.B. Construct other embankment and backfill as follows:

a. **Controlled Density Method.** Deposit cohesive material for embankments and spread in layers no greater than 9 inches deep, loose measure, and extending the full width of the fill area.

   For granular material, attain the required density by depositing, spreading, and compacting in layers no greater than 15 inches deep.

   Provide cohesive material with a moisture content no greater than 3% above optimum at the time of compaction. Provide granular material with a moisture content below saturation in accordance

with the one-point cone chart in MDOT's *Density Testing and Inspection Manual*.

Provide cohesive material in the top 3 feet of embankment with a moisture content not exceeding optimum at time of compaction. For material containing excess moisture, dry to the required moisture content before compacting. Ensure that each layer of material meets moisture requirements, and compact each layer to at least 95% of the maximum unit weight before placing the succeeding layer.

If the required percentage of maximum unit weight and the required moisture content are attained but the compacted material does not provide support for the subbase, the Engineer may direct the Contractor to dry the material by aeration and recompact. Aerate by disking or by manipulating the material using other methods approved by the Engineer.

b. **Twelve-Inch Layer Method**. Deposit the material and spread in layers no greater than 12 inches deep, loose measure, parallel to the finished grade, and extending to the full width of the embankment. Deposit the material by operating the hauling equipment over the layer being placed. Compact each layer to at least 95% of its maximum unit weight in accordance with the 12-inch layer method test in MDOT's *Density Testing and Inspection Manual.*

c. **Rock Embankment.** Use shattered rock from blasting or ripping with the largest dimension no greater than 12 inches to construct rock embankment. Deposit rock on the constructed fill and push over the leading edge to extend the fill. Do not deposit the shattered rock from the hauling equipment directly over the end of the fill. Place the rock embankment in layers no greater than 3 feet thick. Fill the surface of the rock embankment with rock fragments and rock fines to prevent infiltration of the earth embankment. Use granular material Class III to supplement insufficient rock fines to fill the surface of the rock embankment.

Do not use the aforementioned method in fills less than 4 feet deep. Do not place the stones and broken rock layers within 3 feet of the subgrade surface. For structures under rock embankment, provide at least 24 inches of granular material Class III along the sides and the top of structures before placing the rock embankment.

I. **Structure Embankment**

1. **Compaction of Original Ground**. In fill areas on which a structure is required, remove the topsoil from the area within the toes of slope in accordance with subsection 205.03.A.1. Compact the area to at least 95% of the maximum unit weight and at least 9 inches deep.

2. **Placing Structure Embankment**. Place and compact structure embankment to the limits shown on the plans before casting overlying footings. Protect structure embankments from freezing until placement of overlying footings.

   a. **Under Structure Footings Supported by Piling**. Construct structure embankment with granular material Class III within the limits shown on the plans. The Engineer may allow the use of sound earth as an alternate material when placed between April 1 and November 15. Use sound earth as defined in subsection 205.01 except that for rocks, the greatest dimension must be less than 3 inches. Deposit and compact structure embankment in accordance with the controlled density method.

   b. **Under Structure Footings for Which Piling is Not Specified**. Construct structure embankment with granular material Class III within the limits shown on the plans and deposit and compact in accordance with the controlled density method. Compact structure embankment to 100% of the maximum unit weight within the limits of 1:1 slopes, extending outward and downward from the bottom edges of the structure footings.

3. **Winter Grading for Structure Embankment.** Construct embankment during winter weather in accordance with subsection 205.03.H.3 except that before placing embankment to support a structure, remove ground containing frost within the limits of 1:1 slopes spreading outward in every direction from the bottom edges of structure footings. Stockpile frozen material until thawed outside the limits of earth disturbance in areas that are approved by the Engineer.

J. **Machine Grading.** Machine grading consists of light grading, 12 inches deep, to develop the cross section shown on the plans and includes the following:

1. Scarifying;
2. Plowing;
3. Disking;
4. Moving;

5. Compacting; and
6. Shaping the earth.

Loading or hauling material is not required for machine grading.

Grade ditches to drain runoff water. Grade intersections, approaches, entrances, and driveways as shown on the plans or as directed by the Engineer. Obtain the Engineer's approval before using excavation from ditches and roadbeds for shaping shoulders and adjacent fills.

K. **Ditch Cleanout.** Perform ditch cleanout to a depth of no greater than 2 feet based on a typical cross section shown on the plans. Include the following work:

1. Remove cattails, brush, and miscellaneous debris;
2. Remove trees with a diameter of less than 6 inches;
3. Blend ditch profiles to match the existing ditch; and
4. Remove soils/spoils from the project site.

L. **Temporary Railroad Crossing.** Construct temporary railroad crossings in accordance with subsection 107.20.

M. **Granular Blanket.** Excavate unstable soil in the slopes and backfill within the limits and to the depths shown on the plans or as directed by the Engineer. Dispose of excavated material in accordance with subsection 205.03.P.

For granular blanket, Type 1, backfill with granular material Class II.

For granular blanket, Type 2, dress the excavated area with a nominal 3-inch layer of granular material Class II before placing the drainage layer. Construct the drainage layer using one of the following:

1. A 2-inch layer of open-graded aggregate with geotextile blanket above and below;
2. A three-dimensional mesh with geotextile blanket above and below; or
3. Other geocomposite section approved by the Engineer.

Place at least a 12-inch layer of granular material Class II on the drainage layer to bring the slope and ditch section to the required elevation and cross section.

Construct underdrains adjacent to or as a part of the slope protection in accordance with section 404.

N. **Trimming and Finishing Earth Grade.** Construct the earth grade to the required grade. Remove exposed stones and rocks with a diameter greater than 3 inches.

Trim the subgrade to the grade shown on the plans. If a subbase is required, trim the subgrade to within 1 inch of the required grade. If a subbase is not required, trim the subgrade to within ¾ inch of the required grade.

Trim and shape the earth grade outside the subgrade to the required lines, grades, and cross sections. Finish slopes to Class B tolerance unless Class A tolerance is required.

Finish Class A slopes to within 1 inch of the average slopes shown on the plans. Make measurements at right angles to the slope.

Finish Class B backslopes to within 6 inches of the average slopes shown on the plans. Make measurement at right angles to the slope. Do not leave abrupt variations in the finished surface. Remove debris and unsuitable material.

Finish Class B fill slopes to within 2½ inches of the required grade and cross section from the outside shoulder line for 3 feet down the slope. Measure at right angles to the slope. Finish the remainder of the fill slope the same as a Class B backslope.

If trees or other obstacles do not interfere, round the tops of backslopes, bottoms of fill slopes, and other angles in the lines of the cross section to form vertical curves as shown on the plans or as directed by the Engineer. Make vertical curve transitions gradual such that they present a uniform and attractive appearance. The Contractor may omit vertical curves if constructing ditches in peat.

O. **Channel Excavation.** Trim, straighten, widen, deepen, or relocate the channel of a stream or watercourse. Remove and dispose of excavated material. Remove masonry and concrete structures in accordance with section 204. Complete work in the new channel before diverting the stream flow to the new channel. Maintain channels and keep free from debris until final acceptance of the channel.

P. **Disposing of Surplus and Unsuitable Material.** The Department assumes no legal obligation to ensure that the Contractor responsibly disposes of surplus and unsuitable material in accordance with this section. Permits must be obtained as necessary in accordance with subsection 107.02.

1. **Disposal Within the Right-of-Way**. Do not dispose of material, temporarily or permanently, beyond the normal plan fill slope across

regulated or unregulated wetlands or floodplains. The Engineer may allow disposal of material, including associated restoration material, within the right-of-way to fill low areas or flatten slopes at no additional cost to the Department.

2. **Disposal Outside the Right-of-Way.** Do not dispose of material, temporarily or permanently, in regulated or unregulated wetlands or floodplains. Prior to excavation, obtain written permission from the owner of the property including restoration requirements to be used for disposal outside the right-of-way and file the written permission with the Department. Dispose of material and restore areas in accordance with subsection 205.03.H.2 at no additional cost to the Department.

3. **Contractor Responsibility.** The Contractor is directly and solely responsible for disposal of surplus and unsuitable material.

   Contact the appropriate regulatory agencies to determine whether an area is a regulated or unregulated wetland or floodplain before disposing of surplus or unsuitable material in areas outside the right-of-way and not shown on the plans as disposal sites.

   Immediately move to an upland site any surplus or unsuitable material that was disposed of in portions of regulated or unregulated wetlands or floodplains not shown on the plans as disposal sites, at no additional cost to the Department. Restore the vacated area as directed by the applicable regulatory agencies at no additional cost to the Department.

   The Engineer will not consider requests for extensions of contract time without an assessment of liquidated damages for delays associated with moving surplus or unsuitable material to an upland site.

4. **Notification to Regulatory Agencies**. The Department will notify the applicable regulatory agencies if the Department becomes aware that the Contractor disposed of surplus or unsuitable material in portions of a regulated or unregulated wetland or floodplain not shown on the plans.

Q. **Berm Grading.** Remove existing earthen berms along shoulders of the roadway including under existing guardrail to facilitate drainage. Remove all berms from the paved shoulder to the hinge point of the fill slope and grade the slope to provide positive drainage or to the dimensions shown on the plans. Removed berm material, if approved for reuse, must be in accordance with subsection 107.15. Dispose of surplus or unsuitable material in accordance with subsection 205.03.P.

205.04. Measurement and Payment

Pay Item	Pay Unit
Excavation, Earth	Cubic Yard
Granular Material, Cl __	Cubic Yard
Excavation, Rock	Cubic Yard
Excavation, Peat	Cubic Yard
Backfill, Swamp	Cubic Yard
Subgrade Undercutting, Type __	Cubic Yard
Subgrade Manipulation	Square Yard
Embankment, LM	Cubic Yard
Embankment, CIP	Cubic Yard
Embankment, Structure, CIP	Cubic Yard
Machine Grading	Station
Ditch Cleanout	Station
Granular Blanket, Type __	Cubic Yard
Excavation, Channel	Cubic Yard
Berm Grading	Station

A. **Roadway Earthwork Volumes.** Prior to the start of the work, the Engineer and Contractor may agree to accept plan quantity, or the Engineer will calculate roadway earthwork volumes using the average end areas, the staked-section method, or an agreed-to alternative method.

The Engineer will determine the average end areas using the cross sections determined from the original and final elevation measurements. An alternative method such as a comparison of digital terrain models may be used if agreed to by the Contractor and the Engineer prior to the start of work.

For the staked-section method, the Engineer will calculate earthwork quantities by comparing the original cross sections taken before construction to the cross sections taken during and after construction.

The Engineer will take measurements during construction to verify conformance to the required grade and cross sections. The Engineer will adjust quantities for the following:

1. Changes in design;
2. Engineer-authorized deviation from the established grade and cross section;
3. Changes in original ground topography after the original survey was made; or

4. Any changes required by the Engineer during construction such as changing of cut or fill slopes and for excavation of peat, muck, marl, and very soft underlying clay.

B. **General.** The cost to build, maintain, remove, and restore borrow haul routes is included in the unit prices for other pay items.

The Engineer will measure removed topsoil and other selected excavated materials from embankment areas as **Excavation, Earth**.

If the progress clause in the contract requires the Contractor to construct embankments during the seasonal suspension, the Department will pay for the frozen material that is removed and the embankment that is required to replace it at the unit price for **Excavation, Earth** and **Embankment** of the type required. The Engineer will direct the grading limits during the seasonal suspension.

The Department will not pay for removing topsoil and frozen material to facilitate the Contractor's operations.

The unit prices for other pay items include the cost of compacting existing material in embankment and cut sections after removing topsoil.

The Department will pay for the removal of masonry and concrete structures in accordance with section 204.

The Engineer will measure **Granular Material, Cl II** and **Granular Material, Cl III** in place. The Engineer will measure **Granular Material, Cl III** required for constructing fills in water or constructing fills on poorly drained soil as **Backfill, Swamp**.

The Engineer will measure **Underdrains, Bank** in accordance with subsection 404.04.

The cost of trimming the subgrade and slopes to the required tolerances is included in the unit prices for other pay items.

The cost of restoring borrow and disposal areas is included in the unit prices for other pay items.

C. **Excavation, Rock.** The Engineer will measure **Excavation, Rock** using the staked-section method with no allowance for overbreak. The Department considers overbreak the material removed outside the area shown on the plans or the Engineer-approved cross section for rock excavation.

The Engineer will not make deductions for rock projecting inside the lines of the cross section within the limits required.

The Engineer will measure boulders greater than ½ cubic yard individually and will calculate the volume from average dimensions taken in three directions. The Department will pay for boulders greater than ½ cubic yard as **Excavation, Rock**.

The Engineer will measure the removal of overburden as **Excavation, Earth**.

D. **Peat Excavation and Swamp Backfill.** The Engineer will measure total **Excavation, Peat** in its original position.

For the measurement of partial **Excavation, Peat** and displacement, the Engineer will include the volume of the peat that is excavated to form the trench and the excavation of the upheaved peat in the trench. The Engineer will estimate the volume of upheaved peat required for removal from the trench at 100% of the actual peat displaced. The Department will not include peat displaced outside the pay limits shown on the plans in the pay quantity. The Engineer will take borings to determine the depth of displacement for calculating pay quantities.

The Department will pay for excavating peat, muck, marl, and very soft underlying clay as **Excavation, Peat**.

The unit price for **Excavation Peat** includes the cost of rehandling waste material to facilitate displacement.

In the treatment of peat marshes, the Department will not allow claims for delays lasting less than 60 days caused by Department testing and determination of corrective methods. Perform corrective work in areas requiring the total excavation method at no additional cost to the Department.

The Department and the Contractor will share equally the costs for corrective work in areas where the partial peat excavation and displacement method is required or directed by the Engineer. Payment for the corrective work includes excavation and relief trenches. If the Engineer recommends placement of a temporary surcharge, the Department will pay for half the swamp backfill quantity required for the surcharge. The Department will pay for half the quantity of swamp backfill removed as **Excavation, Earth** after the backfill stabilizes or the required settlement occurs.

If shown on the plans, the Department will pay for placement of temporary surcharge at the unit price for **Embankment, CIP** or **Backfill, Swamp**. The Department will pay for the removal of temporary surcharge at the unit price for **Excavation, Earth**.

The cost of maintaining a temporary surcharge, moved forward as the fill progresses, is included in the unit prices for other relevant pay items.

The Engineer will measure **Backfill, Swamp** in its original position. To facilitate measurement, isolate an area in the borrow pit or roadway cut as the exclusive source of material for **Backfill, Swamp**. If the Engineer requires more than initial and final cross sections to measure and calculate the volume of material removed, the Contractor must pay the Department for additional cross sections and calculations.

If not practical to calculate the volume of **Backfill, Swamp** in its original position, the Engineer will calculate the volume within the limits shown on the plans, or from fill borings, and increase the volume by 15%. The Engineer will not increase the **Backfill, Swamp** volume by 15% if the peat excavation results in a dry hole.

The Engineer will not increase the volume of **Backfill, Swamp** by 15% if the material is used to construct sand core fills regardless of whether sand core fills are shown on the plans or directed by the Engineer.

E. **Subgrade Undercutting and Subgrade Manipulation**

1. **Subgrade Undercutting.** The Engineer will measure **Subgrade Undercutting** in its original position. The Department will not make deductions to subgrade undercut quantities in areas where underdrain is installed.

   The Department will not adjust the unit price for changes to the quantity of the type of **Subgrade Undercutting** required.

   The unit price for **Subgrade Undercutting** of the type required includes the cost of removal and disposal of unsuitable material and replacement with required material.

   Payment for geotextile separator required for 4G backfill will be paid for according to subsection 308.04.

2. **Subgrade Manipulation.** The Engineer will measure **Subgrade Manipulation** only in designated areas shown on the plans or directed by the Engineer.

F. **Earth Excavation and Embankment.** The cost of stepping side slopes is included in the unit prices for the related roadway embankment pay items.

1. **Embankment, LM**. The Engineer will measure **Embankment, LM** by volume, loose measure. The unit price for **Embankment, LM** includes the cost of providing, hauling, placing, and compacting material at the required locations.

2. **Excavation, Earth and Embankment, CIP.** Payment for **Excavation, Earth** and **Embankment, CIP** will be based on subsection 205.04.A.

   If material is removed in embankment areas to a greater depth than required, the Department will pay only for the quantities of **Excavation, Earth**; **Embankment, CIP**; and **Embankment, Structure, CIP** as shown on the plans or as directed by the Engineer.

3. **Embankment, Structure, CIP.** The Engineer will measure **Embankment, Structure, CIP** based on the grade and cross section shown on the plans using the staked-section method. The Engineer will not make allowance for increases in quantities of fill material required due to normal consolidation of the natural ground under the embankment.

   The Engineer will measure sound earth if used as structure embankment under pile-supported footings as **Embankment, CIP**.

G. **Machine Grading.** The Engineer will measure **Machine Grading** along the surface edge. The Engineer will measure each side of the road where work is performed, separately.

H. **Ditch Cleanout.** The Engineer will measure **Ditch Cleanout** along the center line of the ditch. Restoration will be paid for separately in accordance with section 816.

I. **Granular Blanket**

1. **Granular Blanket, Type 1**. The Engineer will measure **Granular Blanket, Type 1**, including the volume of granular material Class II, within the limits and to the depth shown on the plans or as approved by the Engineer.

2. **Granular Blanket, Type 2**. The Engineer will measure **Granular Blanket, Type 2** in place and include the volumes of the drainage layer and granular material Class II within the limits and to the depth shown on the plans or as approved by the Engineer.

J. **Channel Excavation.** The Engineer will measure **Excavation, Channel** by volume in its original position.

K. **Berm Grading.** The Engineer will measure **Berm Grading** along the shoulder edge. The Engineer will measure each side of the road where work is performed, separately. The cost for berm grading under guardrail is included in this item. Grading under new or reconstructed guardrail is included in the unit price for the guardrail according to subsection 807.04.A.

Section 208. Soil Erosion and Sedimentation Control

208.01. Description

This work consists of installing and maintaining erosion and sedimentation controls to minimize soil erosion and control sediment from leaving the right-of-way and affecting water resources of the State of Michigan and adjacent properties. Complete this work in accordance with this section and MDOT's *SESC Manual*. The Department considers the terms "stabilization" and "erosion control measures" as defined in the *SESC Manual*.

Failure to install and maintain soil erosion controls may result in project shutdown, fines from the EGLE, or both. The Contractor is responsible for obtaining applicable federal, state, and local permits when disturbing areas outside a Department right-of-way or outside Department-acquired easement areas.

208.02. Materials

Provide materials in accordance with the following sections:

208.03. Construction

A. **Area Limitations.** Conduct work to minimize soil erosion.

Limit the area of earth disturbance to 50 stations of dual roadways or 100 stations of single roadway during clearing and grading. The Engineer may change the limits of exposed surface area based on the Contractor's ability to minimize erosion and prevent offsite sedimentation.

Do not disturb lands and waters outside the limits of earth disturbance within the right-of-way without prior approval from the Engineer. Restore

Contractor-disturbed areas beyond the plan or Engineer-approved limits at no additional cost to the Department.

Obtain and give the Engineer copies of local, state, or federally required permits before disturbing sites outside the right-of-way, such as borrow, waste or disposal areas, haul roads, or storage sites. Provide temporary and permanent erosion and sedimentation controls in accordance with the permits.

B. **Time Limitations.** Bring grading sections to the final earth grade as soon as possible. Completion of the final earth grade does not include topsoil or other permanent restoration measures. The Engineer will consider the earth grade final and ready for placement of topsoil and permanent soil erosion control measures when the Contractor constructs a slope, channel, ditch, or other disturbed area in accordance with subsection 205.03.N.

Complete topsoil placement and stabilize slopes, channels, ditches, and other disturbed areas within 5 calendar days after final earth grade with permanent soil erosion control measures. Permanently restore and place topsoil on slopes and ditches within 150 feet of lakes, streams, or wetlands within 24 hours of achieving final earth grade using permanent soil erosion control measures.

Do not prolong trimming, finishing final earth grade, or both, to permanently stabilize the project at one time.

C. **Construction and Maintenance of Erosion and Sedimentation Controls.** Construct temporary or permanent erosion and sedimentation controls in accordance with the *SESC Manual*, details shown on the plans, or as directed by the Engineer.

Maintain temporary erosion and sedimentation controls as necessary to ensure their effectiveness until permanent stabilization of the disturbed area has occurred. Dispose of sediment and debris removed from temporary sedimentation control devices in accordance with subsection 205.03.P.

Maintain permanent erosion controls as necessary to ensure their effectiveness until project completion and acceptance. Repair damaged areas, replace lost devices, and remove sediment as required. Dispose of sediment and debris removed from permanent sedimentation control devices in accordance with subsection 205.03.P.

1. **Check Dams**. Install, maintain, and remove check dams across ditches.

2. **Sediment Traps and Basins.** Excavate 5 cubic yards or less for sediment traps and greater than 5 cubic yards for sediment basins. Construct, maintain, and fill sediment traps and basins.

   Prevent the excavated material from eroding into lakes, watercourses, or wetlands. Install required check dams downstream from a trap or basin before excavating the trap or basin.

3. **Filter Bag.** Provide, place, and remove at least 225-square-foot filter bags constructed of geotextile blanket. Pump water from the construction area into the filter bag to filter the water before it enters a watercourse. Install gravel filter berms on the downslope side of the filter bag for additional protection in sensitive areas or where the Engineer determines that the filter bag is not effectively removing the sediment. Place the filter bag in an upland vegetated area, on level ground, above, and as far as possible from watercourse banks. Use one pump discharge hose per filter bag. Hose must be of appropriate size for the filter bag. Use multiple filter bags as necessary to ensure effective filtration. The Engineer must approve the location of the filter bag before pumping begins.

   Replace or dispose of the filter bag and its contents when no longer effective or required. Dispose of filter bag and contents in accordance with subsection 205.03.P.

   The Contractor may discharge silt-free, sediment-free water directly to a watercourse.

4. **Sand and Stone Bags**. Provide, place, maintain, remove, and dispose of sand or stone bags. Use non-contaminated sediment-free materials. The stone from stone bags may remain in place after the required period if the bags are cut open and the stone spread evenly, as directed by the Engineer.

5. **Silt Fence**. Provide, install, maintain, remove, and dispose of silt fence consisting of woven geotextile fabric stapled to and supported by posts. Place material removed from trenching in the silt fence on the upslope side of the silt fence. In areas where water ponds behind the silt fence, provide a stone filter to channel away the water and prevent failure. Silt fence may remain in place after the required period if directed by the Engineer.

6. **Gravel Filter Berm**. Provide, place, maintain, remove, and dispose of gravel filter berms consisting of coarse aggregate 6A or open-graded aggregate 34R or 46G. Do not use a gravel filter berm instead of a check dam in a ditch.

7. **Inlet Protection, Fabric Drop**. Provide, place, maintain, and remove fabric drop inlet protection devices as directed by the Engineer. Remove and dispose of accumulated sediment as necessary.

8. **Inlet Protection, Geotextile and Stone.** Provide, place, maintain, remove, and dispose of geotextile blanket, coarse aggregate 6A or open-graded aggregate 34R or 46G, or both, for inlet protection. Remove and dispose of accumulated sediment as necessary.

9. **Inlet Protection, Sediment Trap**. Excavate, provide, maintain, remove, and dispose of sediment traps consisting of geotextile blanket and coarse aggregate 6A or open-graded aggregate 34R or 46G. Remove and dispose of accumulated sediment as necessary.

10. **Temporary Plastic Sheets or Geotextile Cover**. Provide, place, maintain, remove, and dispose of plastic sheets or geotextile cover. Secure temporary plastic sheets or geotextile cover as directed by the Engineer.

11. **Sand Fence.** Provide, maintain, remove, and dispose of fence to prevent sand from migrating onto roads.

12. **Aggregate Cover**. Provide, place, maintain, remove, and dispose of geotextile separator and dense-graded aggregate 21AA, coarse aggregate 3×1, coarse aggregate 6A, or other Engineer-approved material.

13. **Gravel Access Approach**. Provide, place, maintain, remove, and dispose of geotextile separator and coarse aggregate 3×1 or other Engineer-approved material.

14. **Turbidity Curtain**. Provide, install, maintain, remove, and dispose of shallow or deep turbidity curtain.

    Use shallow turbidity curtain when the water is no greater than 2 feet deep. Use deep turbidity curtain when the water is greater than 2 feet deep.

    Provide a floating or staked turbidity curtain. During removal, minimize sediment loss.

15. **Intercepting Ditch**. Construct and maintain intercepting ditches. Remove ditches when no longer needed or as directed by the Engineer.

D. **Removal of Erosion and Sedimentation Control Facilities.** Remove or obliterate temporary erosion and sedimentation controls when the permanent controls are complete and approved unless otherwise directed by the Engineer. Do not remove temporary controls next to lakes,

watercourses, or wetlands until the establishment of turf on the adjacent slopes. Before placing topsoil, permanent seed, and fertilizer, remove or incorporate mulch placed for temporary erosion control into the slope. Minimize erosion and sedimentation into watercourses during removal of erosion controls. Repair damage caused during the removal of erosion controls at no additional cost to the Department.

208.04. Measurement and Payment

Pay Item	Pay Unit
Erosion Control, Check Dam, Stone	Foot
Erosion Control, Sediment Trap	Each
Erosion Control, Sediment Basin	Cubic Yard
Erosion Control, Filter Bag	Each
Erosion Control, Sand Bag	Each
Erosion Control, Stone Bag	Each
Erosion Control, Silt Fence	Foot
Erosion Control, Gravel Filter Berm	Foot
Erosion Control, Inlet Protection, Fabric Drop	Each
Erosion Control, Inlet Protection, Geotextile and Stone	Each
Erosion Control, Inlet Protection, Sediment Trap	Each
Erosion Control, Temp Plastic Sheet/Geotextile Cover	Square Yard
Erosion Control, Sand Fence	Foot
Erosion Control, Aggregate Cover	Square Yard
Erosion Control, Gravel Access Approach	Each
Erosion Control, Maintenance, Sediment Rem	Cubic Yard
Erosion Control, Turbidity Curtain, Shallow	Foot
Erosion Control, Turbidity Curtain, Deep	Foot
Ditch, Intercepting	Station

The Department will not pay for repairing or replacing temporary or permanent SESC measures damaged by the Contractor's negligence. The Department will pay for repairing or replacing temporary or permanent SESC measures damaged by causes other than the Contractor's negligence at the contract unit price for the relevant pay items.

A. **Erosion Control, Check Dam, Stone.** The Engineer will measure **Erosion Control, Check Dam, Stone** in place. The unit price for **Erosion Control, Check Dam, Stone** includes the cost of providing, placing, maintaining, and removing the stone check dam.

B. **Erosion Control, Sediment Trap or Basin**

1. Erosion Control, Sediment Trap. The unit price for **Erosion Control, Sediment Trap** includes the cost of excavating, constructing, maintaining, and removing sediment traps.

The Department will pay separately for removing and disposing of accumulated sediment or debris from a sediment trap as **Erosion Control, Maintenance, Sediment Rem**.

2. **Erosion Control, Sediment Basin.** The Engineer will measure **Erosion Control, Sediment Basin** by volume, loose measure. The unit price for **Erosion Control, Sediment Basin** includes the cost of excavating, constructing, maintaining, and removing the sediment basin.

   The Department will pay separately for removing and disposing of accumulated sediment or debris from a sediment basin as **Erosion Control, Maintenance, Sediment Rem**.

C. **Erosion Control, Filter Bag.** The unit price for **Erosion Control, Filter Bag** includes the cost of providing, placing, maintaining, and disposing of the filter bag and its contents and restoring the filter bag site.

   The Department will pay separately for gravel filter berm used in conjunction with a filter bag as **Erosion Control, Gravel Filter Berm**.

D. **Erosion Control, Sand Bag and Erosion Control, Stone Bag**. The Engineer will measure **Erosion Control, Sand Bag** and **Erosion Control, Stone Bag** in place. The unit prices for **Erosion Control, Sand Bag** and **Erosion Control, Stone Bag** include the cost of providing, placing, maintaining, removing, and disposing of the sand or stone bags.

E. **Erosion Control, Silt Fence.** The Engineer will measure **Erosion Control, Silt Fence** in place excluding overlaps. The unit price for **Erosion Control, Silt Fence** includes the cost of providing, installing, maintaining, removing, and disposing of the fence and posts.

   The Department will pay separately for removing and disposing of accumulated sediment or debris from behind silt fence as **Erosion Control, Maintenance, Sediment Rem**.

F. **Erosion Control, Gravel Filter Berm.** The Engineer will measure **Erosion Control, Gravel Filter Berm** in place. The unit price for **Erosion Control, Gravel Filter Berm** includes the cost of providing, placing, maintaining, removing, and disposing of the gravel filter berm.

G. **Erosion Control, Inlet Protection**

   1. **Erosion Control, Inlet Protection, Fabric Drop**. The unit price for **Erosion Control, Inlet Protection, Fabric Drop** includes the cost of constructing, maintaining, and removing inlet protection fabric drops.

   2. **Erosion Control, Inlet Protection, Geotextile and Stone**. The unit price for **Erosion Control, Inlet Protection, Geotextile and Stone**

includes the cost of constructing, maintaining, and removing geotextile and stone inlet protection.

3. **Erosion Control, Inlet Protection, Sediment Trap**. The unit price for **Erosion Control, Inlet Protection, Sediment Trap** includes the cost of excavating, constructing, maintaining, and removing sediment traps for inlet protection.

The Department will pay separately for removing and disposing of accumulated sediment or debris from a sediment trap inlet protection device as **Erosion Control, Maintenance, Sediment Rem**.

H. **Erosion Control, Temporary Plastic Sheet/Geotextile Cover.** The unit price for **Erosion Control, Temporary Plastic Sheet/Geotextile Cover** includes the cost of constructing, maintaining, and removing temporary plastic sheets and geotextile covers.

I. **Erosion Control, Sand Fence.** The Engineer will measure **Erosion Control, Sand Fence** in place. The unit price for **Erosion Control, Sand Fence** includes the cost of constructing, maintaining, and removing sand fence.

J. **Erosion Control, Aggregate Cover.** The unit price for **Erosion Control, Aggregate Cover** includes the cost of constructing, maintaining, and removing aggregate cover.

K. **Erosion Control, Gravel Access Approach.** The unit price for **Erosion Control, Gravel Access Approach** includes the cost of temporary culverts and ditching required to maintain existing drainage courses through or around gravel access approaches and providing, constructing, maintaining, and removing gravel access approaches.

L. **Erosion Control, Maintenance, Sediment Rem**. The Engineer will measure **Erosion Control, Maintenance, Sediment Rem** by volume, loose measure. The unit price for **Erosion Control, Maintenance, Sediment Rem** includes the cost of removing sediment and debris from erosion and sedimentation control devices as required by the *SESC Manual* and as necessary to ensure their effectiveness.

M. **Erosion Control, Turbidity Curtain.** The Engineer will measure **Erosion Control, Turbidity Curtain, Shallow** and **Erosion Control, Turbidity Curtain, Deep** in place. The unit prices for **Erosion Control, Turbidity Curtain, Shallow** and **Erosion Control Turbidity Curtain, Deep** include the cost of providing, installing, maintaining, and removing turbidity curtains.

The unit price for **Erosion Control, Maintenance, Sediment Rem** includes the cost of removing and disposing of accumulated sediment or debris retained by the turbidity curtain.

N. **Intercepting Ditch.** The Engineer will measure **Ditch, Intercepting** in place along the ditch centerline. The unit price for **Ditch, Intercepting** includes the cost of constructing, maintaining, and removing the intercepting ditch.

Section 301. Subbase

301.01. Description

This work consists of constructing a granular subbase on a surface approved by the Engineer.

301.02. Materials

Provide material in accordance with the following section:

Granular Material Class II 902

301.03. Construction

Spread the subbase material evenly and compact to at least 95% of the maximum unit weight, at a less-than-optimum moisture content, for its entire thickness. Place the subbase in layers no greater than 18 inches. Where the required depth is more than 18 inches, place the material in layers of equal thickness. Construct the subbase to plan grade within a tolerance of plus 1 inch.

Do not place subbase on frozen, soft, unstable, or rutted subgrade. If subbase material becomes mixed with subgrade material, remove, dispose of, and replace the subbase material at no additional cost to the Department.

301.04. Measurement and Payment

Pay Item	Pay Unit
Subbase, LM	Cubic Yard
Subbase, CIP	Cubic Yard

A. **Subbase, LM.** The Engineer will measure **Subbase, LM** based on hauling unit dimensions and load count before placement and compaction. The unit price for **Subbase, LM** includes the cost of providing, hauling, placing, compacting, and grading the material.

B. **Subbase, CIP.** The Engineer will measure **Subbase, CIP** by the staked-section method as described in subsection 205.04. The unit price for **Subbase, CIP** includes the cost of providing, hauling, placing, compacting and grading the material.

Section 302. Aggregate Base Course

302.01. Description

This work consists of constructing an aggregate base course on a surface approved by the Engineer.

302.02. Materials

Provide materials in accordance with the following section:

Dense-Graded Aggregate 21AA, 21A, 22A..... 902

Provide aggregate meeting the aggregate series shown on the plans.

302.03. Construction

A. **Placing and Compacting.** Provide a ticket with each load stating the following information:

1. Project number;
2. Aggregate source;
3. Aggregate series;
4. Date;
5. Time;
6. Truck identifier number;
7. Supplier name; and
8. Type of aggregate approval.

If the contract requires payment by weight, ensure the ticket includes the gross weight, tare weight, and net weight to the nearest 100 pounds. Determine the truck tare weight at least once daily.

If the contract does not require payment by weight, the Engineer may accept written documentation instead of tickets. Written documentation must identify the pay item of the material and include all of the information listed above except time and truck identifier number.

Provide and place aggregate with a uniform gradation, free of contamination and segregation. Do not place aggregate base on frozen, soft, unstable or rutted subgrade, subbase, or aggregate base. Do not rut or distort the subbase material or aggregate base during spreading.

The Contractor may use additives to facilitate compaction, shaping, and maintenance of the aggregate surface.

Compact the aggregate layers to a uniform thickness, no less than 3 inches and no greater than 8 inches. If placing aggregate base in a layer less than 3 inches, blend the new aggregate base material with the layer below to ensure a total of 6 inches. Blending must be performed to ensure that the new aggregate base material is uniformly mixed with the layer below.

Compact each layer of aggregate base to at least 98% of the maximum unit weight at a moisture content no greater than optimum for aggregate base under hot mix asphalt (HMA) pavement. Compact each layer of aggregate base to at least 95% of the maximum unit weight at a moisture content no greater than optimum for aggregate base under concrete pavement. Within the limits of bridge approaches, from the abutment wall to the typical roadway cross section, compact each layer of the aggregate base to at least 98% of the maximum unit weight. Shape the finished surface and the layer thickness to within ±½ inch of the crown and grade shown on the plans.

Remove, dispose of, and replace aggregate base material that mixes with subbase or subgrade material at no additional cost to the Department.

B. **Conditioning Aggregate Base.** Shape the finished surface of the existing aggregate base course to within ±½ inch of the grade and cross section shown on the plans. Provide additional aggregate to address irregularities and obtain the required grade or cross section.

If placing aggregate base in a layer less than 3 inches, blend the new material with the layer below to ensure a total of 6 inches. Blending must be performed to ensure that the new material is uniformly mixed with the layer below and compacted as specified in subsection 302.03.A.

C. **Maintenance During Construction.** Maintain the aggregate base course layer at the required line, grade, and cross section until placement of the next layer. Ensure the exposed aggregate base course layer remains smooth, compacted, and uncontaminated.

If the subgrade, subbase, or aggregate base is damaged due to the Contractor’s operations or construction traffic, restore to the required condition at no additional cost to the Department.

D. **Surplus Existing Aggregate Base Material.** Surplus existing aggregate base material meeting the material requirements described in this section may be used instead of providing new aggregate base material. Remove and dispose of surplus aggregate base material not being used elsewhere on the project and any unsuitable material in accordance with subsection 205.03.P.

302.04. Measurement and Payment

Pay Item	Pay Unit
Aggregate Base	Ton
Aggregate Base, LM	Cubic Yard
Aggregate Base, __ inch	Square Yard
Aggregate Base, Conditioning	Station, Square Yard
Aggregate Base, Conditioning, Surplus and Unsuitable, Rem, LM	Cubic Yard
Salv Aggregate Base, Conditioning, LM	Cubic Yard

A. **Aggregate Base.** The Engineer will determine the moisture content and pay weights in accordance with section 109.

The Engineer will measure **Aggregate Base** by the scale weight of the material, including admixtures, and moisture content no greater than 8%.

The Engineer will perform moisture tests at the start of weighing operations and if construction operations, weather conditions, or other causes may change the moisture content of the material. If tests indicate a moisture content greater than 8%, the Engineer will deduct the weight of the excess moisture from the scale weight of the aggregate until moisture tests indicate the moisture content is no greater than 8%.

B. **Aggregate Base, LM.** The Engineer will measure **Aggregate Base, LM** based on hauling unit dimensions and load count before placement and compaction. The unit price for **Aggregate Base, LM** includes the cost of providing, hauling, placing, compacting, and grading the material and providing water for compaction.

C. **Aggregate Base, __ inch.** The Engineer will measure **Aggregate Base, __ inch** by width and length for the specified depth as shown on the plans.

D. **Aggregate Base, Conditioning.** If the contract requires payment for **Aggregate Base, Conditioning** in station pay units, the Engineer will measure along the alignment of the roadway.

If the contract requires payment for **Aggregate Base, Conditioning** in area pay units, the Engineer will measure by the width and length shown on the plans.

If the contract does not include the pay item **Aggregate Base, Conditioning**, the Department will consider the cost of conditioning aggregate base and of providing additives and water for compaction and maintenance to be included in other aggregate base pay items.

E. **Aggregate Base, Conditioning, Surplus and Unsuitable, Rem, LM.** The Department will pay for **Aggregate Base, Conditioning, Surplus**

and Unsuitable, Rem, LM only if the Contractor removes material from the project site and disposes of it in accordance with subsection 205.03.P.

F. **Salv Aggregate Base, Conditioning, LM.** The Department will pay for **Salv Aggregate Base, Conditioning, LM** for use in other areas of the project only if existing aggregate base material requires loading and hauling. The Engineer will measure and the Department will pay for as **Salv Aggregate Base, Conditioning, LM** surplus material that is loaded and hauled from locations on the project to other locations in order to attain the plan grade or cross section. The Engineer will measure the material in its final location.

Section 306. Aggregate Surface Course and Maintenance Gravel

306.01. Description

This work consists of constructing aggregate surface course on a prepared subgrade or existing aggregate surface.

306.02. Materials

Provide materials in accordance with the following sections:

Dense-Graded Aggregate 21A, 21AA, 22A, 23A, 23AA..... 902
Salvaged Aggregate..... 902

Provide Dense-Graded Aggregate 21A, 21AA, or 22A if the plans show aggregate surface course later receiving a paved surface. Provide Dense-Graded Aggregate 23A or 23AA if the plans show construction of aggregate surface without a paved surface. Provide Dense-Graded Aggregate 21A, 21AA, 22A, 23A, 23AA, or salvaged aggregate for temporary maintenance gravel.

306.03. Construction

A. **Preparation of Base.** When required, blade, or scarify and blade, existing aggregate surfaces to remove irregularities in the grade.

B. **Placing and Compacting.** Provide a ticket with each load stating the following information:

1. Project number;
2. Aggregate source;
3. Aggregate series;
4. Date;
5. Time;
6. Truck identifier number;
7. Supplier name; and
8. Type of aggregate approval.

If the contract requires payment by weight, ensure the ticket includes gross weight, tare weight, and net weight to the nearest 100 pounds. Determine the truck tare weight at least once daily.

If the contract does not require payment by weight, the Engineer may accept written documentation instead of tickets. Written documentation

must identify the pay item of the material and include all of the information listed above except time and truck identifier number.

Provide a uniform aggregate mixture, compacted in place to a uniform density full depth. Provide a complete surface course to the line, grade, or cross section as shown on the plans.

Place maintenance gravel at driveway and intersection locations as shown on the plans or as directed by the Engineer to provide a flush transition to driveways, intersecting cross streets, and adjacent surfaces where maintaining traffic. Grade maintenance gravel to provide positive drainage. Match the existing widths of the driveways and intersections as shown on the plans or as directed by the Engineer.

When construction operations progress to a point that maintenance gravel is no longer needed, as determined by the Engineer, remove the maintenance gravel on the same day as paving of the removal area. Remove and dispose of maintenance gravel in accordance with the standard specifications. If approved by the Engineer, the Contractor may leave maintenance gravel in place as part of the work.

Do not place aggregate on unstable surfaces, as determined by the Engineer. Maintain the aggregate in a smooth and stable condition until removed, surfaced, or project completion.

Compact the aggregate layers to a uniform thickness no greater than 8 inches. If placing HMA surface over the aggregate surface course, compact each aggregate layer to at least 98% of the maximum unit weight at a moisture content no greater than optimum. For other aggregate surface course applications, compact each layer of aggregate to at least 95% of the maximum unit weight at a moisture content no greater than optimum.

Grade the finished surface and layers to within ±½ inch of the crown and grade shown on the plans.

If placing aggregate base in a layer no greater than 3 inches, compact using pneumatic-tired rollers or vibratory compactors to at least 95% of the maximum unit weight at a moisture content no greater than optimum.

C. **Use of Additives.** The Contractor may use additives to facilitate compaction and for dust control.

306.04. Measurement and Payment

Pay Item	Pay Unit
Aggregate Surface Cse, __ inch	Square Yard
Aggregate Surface Cse	Cubic Yard, Ton

Maintenance Gravel, LM..... Cubic Yard
Maintenance Gravel.....Ton
Driveway Maintenance, Commercial ..... Each
Driveway Maintenance, Residential..... Each
Intersection Maintenance..... Each

A. **Aggregate Surface Course.** The Engineer will measure **Aggregate Surface Cse, __ inch** by the width and length shown on the plans.

The Engineer will determine the moisture content and pay weights as specified in section 109.

If the contract requires weight measurement, the Engineer will measure **Aggregate Surface Cse** by the scale weight, including additives, at a moisture content no greater than 8%.

The Engineer will perform moisture tests at the start of weighing operations and when construction operations, weather conditions, or other causes may change the moisture content of the material. If tests indicate a moisture content greater than 8%, the Engineer will deduct the weight of the excess moisture from the scale weight of the aggregate until moisture tests indicate the moisture content is no greater than 8%.

The unit price for **Aggregate Surface Cse, __ inch** and **Aggregate Surface Cse** includes the cost of additives and water.

B. **Maintenance Gravel.** The Engineer will measure **Maintenance Gravel, LM** based on hauling unit dimensions and load count before placement and compaction. The unit price for **Maintenance Gravel, LM** includes the cost of constructing, maintaining, and removing the aggregate surface.

The Engineer will measure **Maintenance Gravel** in tons by the scale weight of the material. The Engineer will perform moisture tests at the start of weighing operations and if construction operations, weather conditions, or other causes may change the moisture content of the material. If tests indicate a moisture content greater than 8%, the Engineer will deduct the weight of the excess moisture from the scale weight of the maintenance gravel until moisture tests indicate the moisture content is no greater than 8%.

The Engineer will determine the moisture content and pay weights as specified in section 109.

C. **Driveway Maintenance, Commercial; Driveway Maintenance, Residential** and **Intersection Maintenance** includes construction, grading, maintenance, removal, replacement, and disposal of the aggregate surface. These items will be paid for once per location

regardless of the number of times the aggregate surface is placed, maintained, removed, or replaced.

Intersection Maintenance will be paid for separately for each approach of the highway, street, or alley that joins or crosses the roadway.

Section 401. Pipe Culverts

401.01. Description

This work consists of constructing pipe culverts of the size and class required, including excavation, bedding, and backfill.

The following terms apply to this section:

Type HE. An elliptical pipe placed with the major axis in the horizontal direction.

Type VE. An elliptical pipe placed with the major axis in the vertical direction.

401.02. Materials

Provide materials in accordance with the following:

Select pipe sections and joint assemblies for use in culverts from the Qualified Products List.

Provide grout for jacked-in-place steel pipe that consists of a mixture of Portland cement and no greater than 50% sand by volume.

Pipe Culverts. Pipe culverts are divided into six classes, as specified in Table 401-1.

Provide the type of culvert material indicated on the plans if shown.

If the contract specifies only the size and class of the culvert, select and provide an alternative culvert pipe allowed in Table 401-1.

A higher strength or greater thickness of culvert may be substituted for the minimum strength or minimum thickness required.

Table 401-1: Pipe Alternatives for Culvert Classes

Type of Pipe	Culvert Class (depth of cover, feet[a])					
	Class A Culvert (1–10)[b][c]	**Class B Culvert (>10–16)**	**Class C Culvert (>16–23)**	**Class D Culvert (>23–33)[c]**	**Class E Culvert (1–3)[c][d]**	**Class F Drive Culvert[e]**
Reinforced concrete[f]	II	III	IV	V	IV	II
Non-reinforced concrete[g]	1	3	No	No	No	1, 3[h]
Corrugated and spiral ribbed al-alloy	Yes	Yes	Yes	Yes	No	Yes
Corrugated and spiral ribbed steel	Yes	Yes	Yes	Yes	No	Yes
Dual-wall polymer-precoated galvanized steel	Yes	Yes	Yes	Yes	No	Yes
Smooth-lined corrugated plastic (CPE)[i][j]	Yes[k][l]	Yes[l][m]	No	No	No	Yes[k][l]
Corrugated polyvinyl chloride (CPV)[n]	Yes[k][l]	Yes[l][m]	No	No	No	Yes[l]

(a) Cover, including the pavement structure, is defined as the height of fill above the top of the pipe measured to final grade.

(b) Class A culvert applies when the culvert is outside the influence of proposed pavement or is beneath the influence of proposed pavement and the depth of cover is >3 feet but ≤10 feet.

(c) Special design is required for fill heights <1 foot and >33 feet.

(d) Class E culvert applies when the culvert is beneath the influence of proposed pavement and the depth of cover is 3 feet or less.

(e) Class F culvert applies for driveway culverts (residential and commercial).

(f) Roman numerals refer to the class of reinforced concrete pipe in accordance with AASHTO M170.

(g) Arabic numerals refer to the class of nonreinforced concrete pipe in accordance with AASHTO M86.

(h) Nonreinforced concrete pipe Class 1 is allowed for Class F culverts with a depth of cover of up to 10 feet. Nonreinforced concrete pipe Class 3 is allowed for Class F culverts with a depth of cover from 10 to 16 feet.

(i) Provide CPE in accordance with AASHTO M294, Type S polyethylene pipe.

(j) At least 2-foot cover if the culvert is outside the influence of proposed pavement (measured from top of pipe to final grade)

(k) Allowed only for 36-inch-diameter pipe and under for CPE and CPV pipes. At least 3 feet of cover.

(l) Refer to the Class A, B and F Bury Plastic Pipe Qualified Products List for approved manufacturers and products.

(m) Allowed only for 12- to 24-inch-diameter CPE and CPV pipes.

(n) CPV must conform to AASHTO M304.

401.03. Construction

A. **Excavation and Culvert Bedding.** Excavate in accordance with subsection 206.03.A. Construct pipe culvert bedding using granular material Class IIIA. Place bedding at least 4 inches deep and uncompacted for the entire length of the culvert. Where rock or hardpan is encountered, excavate the trench to at least 6 inches below the proposed bottom of the pipe; place bedding using uncompacted granular material Class IIIA.

Where unstable soil conditions or obstructions other than rock require excavation of the trench below the elevation detailed on the plans, undercut, backfill, and compact the trench as directed by the Engineer. Use 6A, 17A, 34R, or 46G aggregate as backfill material for undercutting due to unstable soil conditions. Use 34R aggregate for bedding material instead of granular material Class IIIA. Place the backfill up to 4 inches below the proposed bottom of the pipe. The completed work will be paid for as **trench undercut and backfill** according to subsection 402.04.E.

B. **Repair of Damaged Coated Surfaces.** Repair coated culvert surfaces damaged during pipe transportation, handling, or installation at no additional cost to the Department. Repair galvanized culvert surfaces in accordance with subsection 716.03.E or as approved by the Engineer. Repair other coated culvert surfaces as directed by the Engineer.

C. **Laying and Jointing Pipe.** Lay culverts as shown on the plans with bells or grooves upgrade and ends fully and closely jointed. Provide a full, firm bearing throughout the length of the culvert. Wrap all pipe joints with geotextile blanket. Use geotextile at least 36 inches wide, and center it on the joint. Overlap the ends of the geotextile blanket at least 12 inches.

Remove and re-lay culvert sections showing signs of settlement or poor horizontal or vertical alignment as determined by the Engineer. Remove, replace, and mandrel test culverts damaged by the Contractor's operations if required by the Engineer.

Correct settled, misaligned, or damaged culvert sections at no additional cost to the Department.

1. **Corrugated Plastic Pipe (CPE and CPV).** Provide homing marks on CPE and CPV pipe sections and joint material to show the correct alignment of the pipe sections and joint material during field installation.

   After the trench backfill and compaction are complete, the Engineer will select at least 50% of the installed length of each size of CPE and CPV pipe for deformation testing. Provide the labor and equipment required to complete the testing.

Unless otherwise approved by the Engineer, perform the mandrel test within 10 work days prior to pavement surfacing or completion of final grade.

Use a nine-point mandrel with an effective diameter of 95% of the nominal pipe diameter. Provide the Engineer with a proving-ring to verify the mandrel size. Pull the mandrel through the pipe by hand using non-mechanical means and without damaging the pipe. The Contractor may use laser profile technology to measure deflection as an approved alternative to mandrel testing.

Remove and reinstall or replace pipe with a nominal diameter reduced by at least 5% at no additional cost to the Department. Reinstall only undamaged pipe. Do not reinstall pipe without the Engineer's approval.

The Contractor is responsible for all expenses and delays due to the replacement of deformed or damaged pipe.

2. **Concrete Pipe.** Install reinforced concrete elliptical pipe with the longer axis placed horizontally unless otherwise required.

   Install Type HE elliptical pipe with the longer axis within 5 degrees of the horizontal.

   Install Type VE elliptical pipe with the longer axis within 5 degrees of the vertical.

   Install circular concrete pipe with elliptical reinforcement so the lift holes or manufacturer's marks are on the top of the pipe. Place pipe so the lift holes or manufacturer's marks, designating the top and bottom of the pipe, are not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe. After installing the pipe, seal the lift holes with concrete plugs and waterproof.

3. **Metal Pipe.** Provide metal pipe with helical corrugations with a continuous lock seam in accordance with subsection 909.05.

   The use of dissimilar types of base metal (steel or aluminum alloy) or dissimilar types of coatings on steel (zinc or aluminum) in a single line of pipe is prohibited. Construction between dissimilar metal type pipes is not allowed unless a drainage structure is used to transition between the two dissimilar type metals. Changing materials at the drainage structure is allowed if the roughness coefficients have been adjusted accordingly. Use coupling bands of the same base metal and coating metal as the pipe.

4. **Extending Culverts.** When extending a pipe culvert, cast a concrete collar at least 3 inches thick and extending 6 inches on each side of

the joint. Wrap the connecting joint with a 36-inch-wide geotextile strip centered on the joint. When extending an existing corrugated steel pipe with a corrugated steel pipe, a dimple band at least 24 inches wide wrapped with geotextile blanket instead of a concrete collar on the first connection is allowed if the existing culvert is in good condition. Other methods of connecting to the existing pipe require approval of the Engineer before construction. Provide joints tested in accordance with Michigan Test Method (MTM) 723 for the remaining joints of the extension.

D. **Backfilling.** Backfill in accordance with the *MDOT Standard Plan R-83* series and as shown on the plans. Place backfill equally on opposite sides of the pipe at the same time and in layers no greater than 10 inches deep or half the diameter of the pipe, whichever is less. Compact each layer to at least 95% of the maximum unit weight.

Maintain at least 3 feet of cover unless trimming for final grade.

Maintain the line and grade of the culvert during the backfilling operation.

E. **Headwalls and End Sections.** Protect the ends of the culvert using headwalls or end sections constructed in accordance with details on the plans. Construct headwalls in accordance with section 706.

Use precast concrete end sections on concrete culverts in accordance with the *MDOT Standard Plan R-86* series. Construct sloped end sections on concrete culverts as required, using metal or concrete, sloped end sections in accordance with the *MDOT Standard Plan R-95* series. Use precast or cast-in-place footings for precast end sections or precast sloped end sections as required. Form or place the footings at the locations and to the elevations shown on the plans.

Use metal end sections on corrugated metal pipe culverts. Attach metal end sections to the ends of corrugated metal pipe using standard metal bands or other connecting devices as shown on the plans or approved by the Engineer. Provide and install toe plates on the metal end sections if shown on the plans.

Use either precast concrete or metal end sections on CPE. Plastic end sections are prohibited. Fasten end sections to the pipe as recommended by the pipe manufacturer or as directed by the Engineer. The Engineer will allow the use of a metal end section that is one size larger in diameter than the CPE. Slip the end section over the end of the pipe and securely fasten, making sure that the portion of the plastic pipe left exposed is less than 3 inches. If using a concrete end section, wrap the joint with a strip of geotextile blanket 36 inches wide and centered on the joint. Overlap the ends of the geotextile at least 12 inches.

Provide and install end section grates on designated culvert end sections. Fabricate end section grates from weldable-grade hot-rolled steel bars, plain or deformed, of the diameter and configuration shown on the plans. Fasten grates securely to the concrete end sections as shown on the plans.

Place salvaged end sections in accordance with specifications for placing new end sections.

Replace end sections damaged by the Contractor's operation during salvaging or replacing operations with the same size end section as the original at no additional cost to the Department.

When discharging to waters of the state, permanently label all end sections or other points of storm water discharge with "MDOT" or the local agency's name in a conspicuous location that will remain visible after construction. Ensure that the marking is located on the interior of flared end sections in approximate alignment with the spring line of the conduit. For precast or cast-in-place concrete headwalls or when the conduit protrudes through a concrete or steel wall, ensure that the marking is located on the exterior face directly above the pipe or as directed by the Engineer. Refer to the *MDOT Standard Plan R-85, R-86, R-88*, or *R-95* series for specific applications. Labels applied by stenciling utilizing ink, paint, or other surface application are prohibited.

The letters "MDOT" or the local agency's name must be physically stamped into steel end sections, creating an indention in the material. For concrete headwalls, end sections, and walls, the lettering must be physically inscribed into the material. When the conduit protrudes through a steel sheet pile wall, the letters may be placed on the face of the wall by welding.

Individual letters must be legible and each sized to 1½ inches high by 1 inch wide. The depth of the letters must be a minimum of $^1/_4$ inch for concrete and $^1/_8$ inch for steel materials. If the letters are placed by welding, the thickness of the weld must be at least $^1/_4$ inch.

F. **Drainage Marker Posts.** Place drainage marker posts at headwalls and culvert end sections for culverts with a diameter no greater than 36 inches and at outlet endings. Install drainage marker posts at least 2 feet deep or as recommended by the manufacturer.

G. **Pipe Culverts Jacked in Place.** Jack the culvert into place to the line and grade shown on the plans or established by the Engineer.

If jacking pipe under railroad tracks, submit to the Engineer sheeting and bracing plans for the jacking pits for approval by the railroad company. Do not begin excavating the jacking pit until receipt of the approval.

Excavate the approach trench so it is large enough to accommodate jacks and blocking and at least one section of pipe. Lay two rails or sills in the bottom of the trench to keep the pipe at the established line and grade.

Minimize excavation ahead of the pipe to prevent caving of the earth. The Engineer will allow attachment of a steel cutting edge or shield to the front section of pipe to form and cut the required opening for the pipe.

A steerable pipe jacking shield must be used on the lead pipe.

The annular space between the casing and the carrier pipe must be bulkheaded in accordance with subsection 402.03.E and grouted with an Engineer-approved material.

Fill voids between the excavation and the pipe using materials and placing methods approved by the Engineer.

1. **Obstructions.** The Engineer will measure and the Department will pay for the removal of obstructions that require the use of special procedures or tools at the unit price for Obstruction Removal, in accordance with subsection 718.04.D.

H. **Steel Pipe Jacked in Place.** Jack steel pipe in place to serve as a carrier pipe or casing for a carrier pipe. Jack steel pipes in place in accordance with subsection 401.03.G. Bulkhead the ends of steel pipe used as casing for carrier pipe in accordance with subsection 402.03.E. The annular space between the carrier pipe and the casing must be completely filled with grout approved by the Engineer.

Obstructions must be removed in accordance with subsection 401.03.G.1.

I. **Steel Casing Pipe.** Install steel casing pipe in a trench as shown on the plans. Provide steel casing pipes placed for future use with a temporary bulkhead at each end to prevent infiltration into the pipe.

Obstructions must be removed in accordance with subsection 401.03.G.8.

J. **Disposal of Surplus Material.** Take possession and dispose of surplus material in accordance with subsection 205.03.P.

K. **Cleanout.** Maintain culverts installed on the project. Ensure that they are free of silt, debris, and other foreign matter above the flow line of the drainage course at the time of final acceptance and in accordance with section 209.

L. **Video Inspection.** Video inspect culverts as specified for sewers in subsection 402.03.J. Video inspection is not required for the following:

1. Driveway culverts;

2. Culvert extensions less than 50 feet;

3. New culverts less than 50 feet; or

4. Extensions of existing catch basin leads less than 20 feet.

M. **Dewatering and Maintaining Stream Flow during Construction.** Maintain the stream flow through the existing channel, temporary channel, temporary culvert, or bypass pumping unless approved by the Engineer.

Prepare a bypass pumping or bypass flow control plan that complies with the Michigan Department of Environment, Great Lakes, and Energy (EGLE) permit requirements and the MDOT Standard Plans and submit it to the Engineer for review 10 days before installing the system.

When using a temporary bypass pipe, sluice, or similar structure, provide sediment control structures at the inlet to contain sediment before it enters the bypass structure. Maintain the sediment control structure to provide adequate flow and sediment removal capacity.

Install temporary dams constructed of sufficient size and depth to withhold the expected backwater. Temporary uncontained material earthen dams are prohibited.

Dewater without causing damage to nearby property, foundations, utilities, or pavements and without interfering with the rights of the public, owners of private property, pedestrians, motorists, or the work of other contractors.

Do not disturb the soil under and next to existing structures during dewatering and temporary pumping operations. The Contractor is responsible for controlling any additional sediment created by Contractor operations. Do not overload or obstruct existing drainage facilities.

401.04. Measurement and Payment

Pay Item	Pay Unit
Culv, Cl __, __ inch	Foot
Culv, Cl __, (material), __ inch	Foot
Culv, Downspout __ inch	Foot
Culv, Outlet Headwall, __ inch	Each
Culv, Reinf Conc Ellip, (shape) Cl __, (rise) inch by (span) inch	Foot
Culv, CSP Arch, Cl __, (span) inch by (rise) inch	Foot
Culv, Slp End Sect, (slope), __ inch, Longit	Each
Culv, Slp End Sect, (slope), __ inch, Transv	Each
Culv, Slp End Sect, Arch Pipe, (slope), (span) inch by (rise) inch, Longit	Each
Culv, Slp End Sect, Arch Pipe, (slope), (span) inch by (rise) inch, Transv	Each

Culv, Slp End Sect, Ellip Pipe, (slope), (rise) inch by (span) inch, Longit ..... Each
Culv, Slp End Sect, Ellip Pipe, (slope), (rise) inch by (span) inch, Transv ..... Each
Culv End Sect, (material), __ inch ..... Each
Culv End Sect, __ inch ..... Each
Culv End Sect, Footing ..... Each
Culv End Sect, Grate ..... Each
Culv, Cl __, __ inch, Jacked in Place ..... Foot
Steel Casing Pipe, __ inch, Jacked in Place ..... Foot
Steel Casing Pipe, __ inch, Tr Det __ ..... Foot
Dr Marker Post ..... Each
Culv End Sect, Salv, 30 inch or less ..... Each
Culv End Sect, Salv, over 30 inch ..... Each
Outfall Label ..... Each

A. **Culverts.** The Engineer will measure culverts of the diameter, class, or material required, by length, excluding the length of end sections as shown on the plans. The unit prices for culverts include the cost of the following:

1. Excavating the material down to grade or to the culvert bedding bottom elevation;
2. Dewatering and maintaining the stream flow during construction stages;
3. Providing and placing the culvert and geotextile strip;
4. Providing temporary cover and restraining the pipe to maintain line and grade;
5. Providing, placing, and compacting the backfill;
6. Conducting mandrel testing if required; and
7. Disposing of excess material.

B. **Culvert, Jacked in Place.** The Engineer will measure **Culv, Cl __, __ inch, Jacked in Place** of the class and size required, by length, as determined by multiplying the number of units jacked by the commercial laying length. The unit price for **Culv, Cl __, __ inch, Jacked in Place** includes the cost of excavating the pit; providing and installing sheeting, bracing, and other safety devices; providing jacking equipment; drainage and dewatering; and other items associated with the operation.

C. **Culvert End Sections**

1. **End Sections.** The unit price for **Culv, Slp End Sect** of the size or type required includes the cost of providing and placing end sections, including longitudinal and cross tubes as detailed in the *MDOT Standard Plan R-95* series.

   The unit price for **Culv End Sect** of the size or type required includes the cost of providing and placing the end section.

   The unit price for **Culv End Sect, Metal, __ inch** includes the cost of providing and placing the end section and toe plate, as shown on the plans or in the *MDOT Standard Plans*.

   If the Contractor provides corrugated plastic pipe, the Department will pay for culvert end sections of the diameter that is required for the culvert even if the Contractor provides a metal end section larger than the nominal diameter of the pipe.

   The unit price for culvert end sections includes the cost of fastening the end section to the pipe and wrapping the joint with geotextile blanket. The Department will pay for required riprap in accordance with subsection 813.04.

   The unit price for **Outfall Label** includes the cost of providing and installing the label as described in subsection 401.03.E.

2. **Culvert End Sections, Footing.** The Department will pay for footings required for precast concrete end sections as **Culv End Sect, Footing**. The unit price for **Culv End Sect, Footing** includes the cost of the following for the footing as shown on the plans:

   a. Excavating and forming;

   b. Providing and placing the steel reinforcement; and

   c. Providing, placing, finishing, and curing the concrete.

3. **Culvert End Sections, Salvage.** The unit price for **Culv End Sect, Salv** includes the cost of removing the existing end section, salvaging and storing, and reinstalling end sections.

4. **Culvert End Section, Grate.** The Engineer will measure **Culv End Sect, Grate** by each as shown on the plans for the size of grate required.

D. **Headwalls.** The Engineer will measure and the Department will pay for headwalls as steel reinforcement and concrete, Grade 3500, in accordance with subsection 706.04. If the Contractor uses precast wingwalls, headwalls, and aprons instead of cast-in-place wingwalls,

headwalls, and aprons, the Department will pay for them as the corresponding pay items for the cast-in-place wingwalls, headwalls, and aprons as required by the contract.

The unit price for **Culv, Outlet Headwall** includes precast outlet headwalls as shown in the *MDOT Standard Plan R-85* series and will be paid for by each.

E. **Jacked-in-Place Steel Pipe.** The Department will not pay separately for jacked-in-place steel pipe that is used at the Contractor's discretion to act as a casing for the carrier pipe. The cost of grouting between the carrier and casing pipes is included in payment for the carrier pipe.

F. **Steel Casing Pipe.** The unit price for steel casing pipe includes the cost of excavation and backfill.

The Department will pay separately for carrier pipe inserted into a steel casing pipe. The unit price for the carrier pipe includes the cost of casing chocks, inserting the carrier pipe, and required grouting.

G. **Videotaping Sewer and Culvert Pipe.** The Engineer will measure and the Department will pay for videotaping sewer and culvert pipe in accordance with subsection 402.04.

H. **Rock Excavation.** The Engineer will measure and the Department will pay separately for rock excavation in accordance with subsection 205.04.

I. The unit price for **Dr Marker Post** includes the cost of providing and installing the post as described in subsection 401.03.F.

J. The unit price for **Obstruction Removal** will be paid for in accordance with subsection 718.04.D.

Section 402. Storm Sewers

402.01. Description

This work consists of constructing storm sewers of the size and class required, including excavation, bedding, and backfill.

The following terms apply to this section:

Type HE. An elliptical pipe placed with the major axis in the horizontal direction.

Type VE. An elliptical pipe placed with the major axis in the vertical direction.

402.02. Materials

Provide materials in accordance with the following sections:

Select pipe with watertight joint systems from the Qualified Products List.

Storm sewers are divided into five classes, as specified in Table 402-1. If the contract specifies only the size and class of sewer, select and provide an alternative storm sewer pipe allowed in Table 402-1.

For types of sewer material that are required but are not included in Table 402-1, the contract will specify the type and size of sewer material.

A higher strength or greater thickness of sewer may be substituted for the minimum required sewer strength or minimum required thickness.

Table 402-1: Pipe Alternatives for Storm Sewer Classes

Type of Pipe	Storm Sewer Class (depth of cover, feet[a])				
	Class A Sewer (1–10)[b][c]	Class B Sewer (>10–16)	Class C Sewer (>16–23)	Class D Sewer (>23–33)[c]	Class E Sewer (1–3)[c][d]
Reinforced concrete[e]	II	III	IV	V	IV
Nonreinforced concrete[f]	1	3	No	No	No
Corrugated and spiral ribbed al-alloy[g]	Yes	Yes	Yes	Yes	No
Corrugated and spiral ribbed steel[h]	Yes	Yes	Yes	Yes	No
Dual-wall polymer-precoated galvanized steel	Yes	Yes	Yes	Yes	No
Smooth-lined corrugated plastic (CPE)[i]	Yes[j][k]	Yes[k][l]	No	No	No
Corrugated polyvinyl chloride (CPV)[m]	Yes[j][k]	Yes[k][l]	No	No	No

(a) Cover, including the pavement structure is defined as the height of fill above the top of the pipe measured to final grade.

(b) Class A sewer applies when the sewer is outside the influence of proposed pavement or is beneath the influence of proposed pavement and the depth of cover is >3 feet but ≤10 feet.

(c) Special design is required for depths of cover <1 foot and >33 feet.

(d) Class E Sewer applies when the sewer is beneath the influence of proposed pavement and the depth of cover is ≤3 feet.

(e) Roman numerals refer to class of reinforced concrete pipe in accordance with AASHTO M170.

(f) Arabic numerals refer to the class of nonreinforced concrete pipe in accordance with AASHTO M86.

(g) Allowed for 12- to 66-inch spiral ribbed and 12- to 18-inch helically corrugated 2⅔ by ½ inch aluminum alloy pipe only.

(h) Allowed for 12- to 84-inch spiral ribbed and 12- to 18-inch helically corrugated 2⅔ by ½ inch steel pipe only.

(i) Provide CPE in accordance with AASHTO M294, Type S polyethylene pipe.

(j) Allowed only for 36-inch-diameter pipe and under for CPE and CPV pipes. At least 3 feet of cover.

(k) Refer to the Class A, B and F Bury Plastic Pipe Qualified Products List for approved manufacturers and products.

(l) Allowed only for 12- to 24-inch diameter CPE and CPV pipes.

(m) CPV must conform to AASHTO M304.

402.03. Construction

A. **Excavation, Trench Construction, and Sewer Bedding.** Perform trench construction using methods that meet the health and safety requirements specified in subsection 104.07.

Excavate the trench as shown on the plans or as determined by the Engineer. Construct the trench width to at least the minimum width shown in the *MDOT Standard Plan R-83* series and wide enough to provide free working space and allow compaction of the backfill around the pipe. Shape the bottom of the trench to support the pipe uniformly. Place bedding using uncompacted granular material Class IIIA to the required elevation.

Where unstable soil conditions or obstructions other than rock require excavation of the trench below the elevation detailed on the plans, undercut, backfill, and compact the trench as directed by the Engineer. Use 6A, 17A, 34R, or 46G aggregate as backfill material for undercutting due to unstable soil conditions. Use 34R aggregate for bedding material instead of granular material Class IIIA. Place the backfill up to 4 inches below the proposed bottom of the pipe. The completed work will be paid for as Trench Undercut and Backfill according to subsection 402.04.E.

During sewer construction, maintain and protect existing live utilities. Minimize service interruptions and coordinate with the local municipality or utility company. Immediately repair or replace utilities interrupted during sewer construction as directed by the Engineer.

B. **Repair of Damaged Coated Surfaces.** Repair coated pipe surfaces damaged during pipe transportation, handling, or installation, at no additional cost to the Department. Complete repair of galvanized pipe surfaces in accordance with subsection 716.03.E or as approved by the Engineer. Repair other coated sewer pipe surfaces as directed by the Engineer.

C. **Laying and Jointing Pipe.** Lay storm sewers as shown on the plans with bells or grooves upgrade and ends fully and closely jointed. Provide a full, firm bearing along the length of each pipe section. Wrap all pipe joints with geotextile blanket. Use geotextile at least 36 inches wide and center it on the joint. Overlap the ends of the geotextile blanket at least 12 inches.

Remove and replace pipe damaged by Contractor operations. After trench backfill and compaction is complete, mandrel test replaced CPE and CPV pipe. Remove and re-lay sewer sections showing signs of settlement or poor horizontal or vertical alignment as determined by the Engineer at no additional cost to the Department.

1. **Corrugated Plastic Pipe (CPE and CPV).** Provide homing marks on CPE and CPV pipe sections and joint material to show the correct alignment of the pipe sections and joint material during field installation.

   After trench backfill and compaction is complete, the Engineer will select at least 50% of the installed length of each size of CPE and CPV pipe for deformation testing. Provide the labor and equipment that are required to complete the testing.

   Unless otherwise approved by the Engineer, perform the mandrel test within 10 work days prior to pavement surfacing or completion of final grade.

   Use a nine-point mandrel with a diameter equal to 95% of the nominal pipe diameter. Provide the Engineer with a proving-ring to verify the mandrel size. Pull the mandrel through the pipe by hand using non-mechanical means and without damaging the pipe. The Contractor may use laser profile technology to measure deflection as an approved alternative to mandrel testing.

   Remove and reinstall or replace pipe with a nominal diameter reduced by at least 5% at no additional cost to the Department. Reinstall only undamaged pipe. Do not reinstall pipe without the Engineer's approval.

   The Contractor is responsible for all expenses and delays caused by reinstallation or replacement of pipe.

2. **Concrete Pipe.** Install reinforced concrete elliptical pipe with the longer axis placed horizontally unless otherwise required.

   Install Type HE elliptical pipe with the longer axis within 5 degrees of horizontal.

   Install Type VE elliptical pipe with the longer axis within 5 degrees of vertical.

   Install circular concrete pipe with elliptical reinforcement so the lift holes or manufacturer's marks are on the top of the pipe. Place pipe so the lift holes or manufacturer's marks designating the top and bottom of the pipe are no more than 5 degrees from the vertical plane through the longitudinal axis of the pipe. After installing the pipe, seal the lift holes with concrete plugs and waterproof.

3. **Metal Pipe.** Provide metal pipe with helical corrugations with a continuous lock seam in accordance with subsection 909.05.

Use of dissimilar types of base metal (steel or aluminum alloy) or dissimilar types of coatings on steel (zinc or aluminum) in a single line of pipe is prohibited. Construction between dissimilar metal type pipes is not allowed unless a drainage structure is used to transition between the two dissimilar type metals. Changing materials at the drainage structure is allowed if the roughness coefficients have been adjusted accordingly. Use coupling bands of the same base metal and coating metal as the pipe.

D. **Sewer Taps.** Make connections to storm sewers owned by counties, municipalities, or drain commissions in accordance with the regulations of the owner and as required by the contract. If a conflict exists between the owner's regulations and these specifications, the owner's regulations will take precedence.

For existing storm sewers with plugs or bulkheads, remove plugs or bulkheads without damaging the existing sewer and make watertight joint connections. Remove material in accordance with subsection 204.03.B.

If tapping an existing pipe, cut an opening in the receiving pipe at least 6 inches larger than the outside diameter of the inlet pipe. Insert the inlet pipe and cut flush with the inner wall of the receiving pipe. Pack a layer of mortar at least 3 inches thick around the inlet pipe and strike smooth with the inner wall of the receiving pipe. Encase the inlet pipe on the outside of the connection with concrete to provide bearing under the pipe. Repair or replace existing pipe damaged by Contractor tapping operations at no additional cost to the Department.

Do not direct tap sewer inlet pipes with outside diameters greater than half the inside diameter of the trunk sewer. Construct a manhole structure for these taps in accordance with section 403. Obtain the Engineer's approval before using other methods of tapping existing sewers.

E. **Sewer Bulkheads.** Construct sewer bulkheads using Grade 3000 concrete or brick or block masonry. Extend the bulkhead at least 1 foot into the pipe from the inner wall of the drainage structure. Construct masonry bulkheads in accordance with subsection 403.03.A.

F. **Backfilling.** Backfill in accordance with subsection 401.03.D.

G. **Sewer Jacked in Place.** Jack sewers in place in accordance with subsection 401.03.G.

H. **Disposal of Surplus Material.** Take possession and dispose of surplus material in accordance with subsection 205.03.P.

I. **Cleanout.** Maintain storm sewers installed on the project. Verify that installed sewers are free of silt, debris, and other deleterious material at the time of final acceptance and in accordance with section 209.

J. **Video Inspection of Sewer Pipe.** Use closed circuit television to inspect required storm sewers. Dewater or divert flow in sewers for inspection. Video inspection is not required for extensions of existing catch basin leads less than 20 feet.

After backfilling and compacting the trench, and within 10 working days prior to pavement surfacing or completion of final grade, conduct the inspection of sewers under pavement unless otherwise approved by the Engineer.

For sewers not under pavement, after backfilling and compacting the trench, conduct the inspection as close to project completion as possible but allow time for corrective action as determined by the video inspection and directed by the Engineer.

1. **Traffic Control.** Obtain the Engineer's approval of traffic control measures at least 5 days before beginning work. Propose a traffic control plan in accordance with the *Michigan Manual of Uniform Traffic Control Devices* (MMUTCD) and the maintaining traffic plans in the contract.

   Unless otherwise approved by the Engineer, keep traffic lanes open. For necessary lane or shoulder closures, use traffic control measures in accordance with the traffic control plan.

2. **Equipment.** Use a camera designed and constructed for inspecting sewers and equipped with the following features:

   a. A pan and tilt head external to the main body of the camera to allow inspection of the sewer joints and cracks or other defects;

   b. Lighting to allow a clear picture of the perimeter of the pipe; and

   c. Underwater operation capable of producing a picture quality that is satisfactory to the Engineer.

   d. Show or document camera magnification at all times in the video.

   If the Engineer determines the video quality is not satisfactory, re-inspect the pipes to obtain acceptable results at no additional cost to the Department.

   Use continuous running video capable of recording audio and video information. Include the date (month, day, and year) and camera location. Provide a continuous record of the sewer section from manhole to manhole or from end to end. Use high quality, color, digital

format at a standard play speed. Obtain the Engineer's approval before using other recording media.

3. **Sewer Flow Control.** For video inspection, provide flow control to bring the depth of flow in the sewer pipe to within the range specified in subsection 402.03.J.6.a. Before starting work, submit the proposed method of sewer flow control to the Engineer for approval.

    a. **Depth of Flow.** Lower the depth of flow in the sewer during the videotaping operation to less than 2 inches. Reduce flow by plugging or blocking the flow or by pumping the flow and bypassing the pipe section during inspection, as approved by the Engineer.

    b. **Plugging or Blocking.** Insert a sewer line plug into the line upstream of the section undergoing inspection. Use a plug designed to allow the release of portions of the flow. During video inspection, reduce the flow depth to 2 inches. Restore normal flow after completing the work. Meter flow discharge to prevent erosion.

    c. **Pumping and Bypassing.** For pumping and bypassing, supply the pumps, conduits, and other equipment to divert the flow around the sewer section undergoing inspection. Provide a bypass system with a capacity to handle existing flow plus additional flow that may occur during a rain event. Provide the labor and supervision required to set up and operate the pumping and bypassing system.

    d. **Flow Control Precautions.** If the flow in a sewer line is plugged, blocked, or bypassed, protect the sewer lines from damage that may result from sewer surcharging. Do not cause flooding or damage to public or private property while controlling sewer flow.

4. **Procedure.** Move the camera through the line at a rate no greater than 0.5 feet per second, stopping as required to document the joint and pipe conditions. Use winches, cable, powered rewinds, or other devices that do not obstruct the camera view or interfere with proper documentation of the pipe conditions.

    Adjust the camera to travel above the level of the flow in the pipe. If the camera encounters a dip in the pipe such that the water rises above the springline of the pipe or if the camera lens becomes submerged, withdraw the camera and re-insert it from the other end as far as possible. Do not back the camera into a pipe undergoing inspection.

    Measure the distance to the location of defects above ground using a meter device. Marking defect locations on the cable to measure the

distance to defects is not allowed. Provide a distance meter with an accuracy within 1 foot and check using a walking meter, roll-a-tape, or other device.

5. **Documentation.** Provide the inspection to the Engineer in a digital format. Include a written log of damages or installation defects, including pipe deformation, cracking, joint separation, corrosion, perforation, and other features identified in the video. Provide a digital copy of the log to the Engineer. Locate the damage or defect by meter marking of the video in the inspection log. Label the videos to describe the reaches of sewer or culverts contained in the videos, including street location and manhole numbers. If manhole numbers are not provided, assign a numbering system to allow identification in the inspection report and video.

402.04. Measurement and Payment

Pay Item	Pay Unit
Sewer, Cl __, __ inch, Tr Det __	Foot
Sewer, Reinf Conc Ellip, (shape) Cl __, (rise) by (span) inch, Tr Det __	Foot
Sewer, Cl __, __ inch, Jacked in Place	Foot
Sewer Tap, __ inch	Each
Sewer Bulkhead, __ inch	Each
Trench Undercut and Backfill	Cubic Yard
Dewatering System, Trench	Foot
Video Taping Sewer and Culv Pipe	Foot

A. **Sewer and Sewer, Reinforced Concrete Elliptical.** The Engineer will measure **Sewer** and **Sewer, Reinf Conc, Ellip** of the size, class, and trench detail required, in place from center to center of manholes, catch basins, or inlets. The unit price for **Sewer** and **Sewer, Reinf Conc, Ellip** includes the cost of excavation, backfill, and geotextile blanket.

B. **Sewer, Jacked in Place.** The Engineer will measure **Sewer, Jacked in Place** of the size and class required, by length, as determined by multiplying the number of units jacked by the commercial laying length. The unit price for **Sewer, Jacked in Place** includes the cost of excavating the pit; providing and installing sheeting, bracing, and other safety devices; providing jacking equipment; drainage and dewatering; and other items associated with the operation.

C. **Sewer Tap.** The Engineer will measure **Sewer Tap** based on the inlet pipe size required, by each tap into an existing system. If tapping an existing sewer line using a drainage structure, the Department will pay for one sewer tap in addition to the drainage structure.

D. **Sewer Bulkhead.** The Engineer will measure only sewer bulkheads for storm sewers with a diameter larger than 12 inches. The cost of constructing sewer bulkheads for pipes with a diameter less than or equal to 12 inches or constructed as part of abandoning or removing drainage structures as shown on the plans is included in the unit prices for related pay items.

   The Department will pay separately for bulkheading pipes greater than 12 inches.

E. **Trench Undercut and Backfill.** The Engineer will measure **Trench Undercut and Backfill** by calculating the volume from the length, depth, and width of undercut authorized by the Engineer and shown on the plans. The Engineer will not make allowance for sloping the sides of the trench. The unit price for **Trench Undercut and Backfill** includes the cost of excavation and disposal of material and providing, placing, and compacting 6A, 17A, 34R, or 46G aggregate to the bottom of trench elevation shown on the plans.

F. **Rock Excavation.** The Engineer will measure and the Department will pay separately for rock excavation in accordance with subsection 205.04.

G. **Dewatering System, Trench.** If the contract does not include a pay item for **Dewatering System, Trench** and the Contractor uses a dewatering system, the Department will not pay separately for the system but will consider the cost to be included in the unit price for related pay items.

H. **Trenchless.** The Engineer may authorize trenchless methods, in place of open-cut construction methods. The Department will delete or proportionally reduce pay item quantities required for corresponding open-cut construction from the contract if the Engineer authorizes trenchless methods. The Department will not make an adjustment in the pay items of **Minor Traf Devices** or **Traf Regulator Control.**

   Payment for the work performed by trenchless methods will not exceed the unit price bid for the open-cut method.

   If the Engineer authorizes trenchless installation, **Obstructions** will be removed in accordance with subsection 718.03.F.2. Additional payment or delays for removal of obstructions will not be considered.

I. **Video Taping Sewer and Culvert Pipe.** The unit price for **Video Taping Sewer and Culv Pipe** includes the cost of dewatering, flow control, video inspection, and documentation.

   The Department will pay separately for traffic maintenance and control in accordance with subsection 812.04.

J. **Obstructions.** Engineer will measure, and the Department will pay for the removal of obstructions, which require the use of special procedures at the unit price for **Obstruction Removal** in accordance with subsection 718.04.D.

Section 403. Drainage Structures

403.01. Description

This work consists of adjusting, constructing, or temporarily lowering drainage structures and cleaning existing drainage structures and leads as directed by the Engineer.

Drainage structures include manholes, catch basins, leaching basins, inlets, and drop inlets.

Drainage Structure. Includes concrete footing or precast sump. Used for access to new or existing sewers with a diameter no greater than 48 inches.

Manhole Base, Type 1 or Type 2, and Manhole Riser. Used for access to new or existing sewers with a diameter of at least 48 inches. Manhole Base Type 1 may be substituted for Precast Manhole Tees. **Precast Manhole Tee and Manhole Riser.** Used for access to new sewers with diameters of at least 42 inches.

Manhole Base, Type 1 or Type 2, and Manhole Riser. Used for access to new or existing sewers with a diameter of at least 48 inches. Manhole Base Type 1 may be substituted for **Precast Manhole Tees**.

403.02. Materials

Provide materials in accordance with the following sections:

Provide cast-in-place or precast concrete construction for sanitary sewer manholes.

Provide structural steel plate, at least ½ inch thick, for temporary lowering of drainage structures that span 72 inches or less. Verify that plates cover the entire drainage structure with a bearing surface of at least 12 inches. For plates that span greater than 72 inches, submit structural calculations prepared by a Professional Engineer licensed in the State of Michigan to the Engineer.

Provide leveling course hot mix asphalt (HMA) for patching during the temporary lowering operations or other HMA mixture as approved by the Engineer.

403.03. Construction

A. **Constructing, Adjusting, and Temporary Lowering of Drainage Structures, Precast Manhole Tees, Manhole Bases, and Manhole Risers**

1. **Excavation.** Excavate for constructing, adjusting, and temporarily lowering drainage structures, precast manhole tees, manhole bases, and manhole risers in accordance with subsection 206.03.A.

2. **Concrete Construction.** Construct concrete portions of drainage structures in accordance with subsection 706.03. Do not cast drainage structures if the concrete temperature is above 90°F.

3. **Placing Brick and Block Masonry.** Do not place masonry with mortar when the ambient air temperature is 36°F or less unless approved by the Engineer. Remove and replace work damaged by frost. Apply a ½-inch-thick plaster coat of mortar to the outer surface of structures and to the inner surface below the outlet flow line on catch basins with traps or sumps. Place the first set of bricks or blocks on a full bed of mortar. Lay brick or block in courses with uniform mortar joints ½ inch thick within ⅛ inch of depth. Stagger joints by half the length of the brick or block on adjoining courses. Place courses level unless otherwise required. Strike and point joints so the exposed surface is smooth. Rake joints and wet brick or block before placing the plaster coat. Allow the brick or block surface to dry to provide for proper bonding of the plaster coat.

   Wet the brick. Allow the brick surface to dry to allow the brick and mortar to bond. Use of broken or chipped brick on the faces of the structure is prohibited. Provide a course made of headers at least every seventh course. Make closures with brick lengths no less than the width of a whole brick.

4. **Precast Reinforced Concrete Units.** Use poured-in-place concrete in accordance with subsection 403.03.A.2 or precast concrete footings. Construct precast reinforced concrete units in accordance with the contract. Seal the joints with mortar in accordance with subsection 403.03.A.3, or use butyl rubber sealant that conforms to ASTM C990. Support precast concrete footings on a 6-inch subbase of compacted granular material Class II.

5. **Steel Reinforcement.** Install steel reinforcement in accordance with subsection 706.03.

6. **Inlet and Outlet Pipes.** Place and compact backfill around the manhole base or sump to provide bedding for inlet and outlet pipes.

   Extend inlet and outlet pipes through the outside wall surface of the manhole a sufficient length to allow for pipe connections. Construct masonry around pipes and seal with mortar or other product approved by the Engineer to prevent leakage.

7. **Backfilling.** Backfill in accordance with subsection 401.03.D.

   Stage backfilling to coordinate with the construction sequencing of the structure as necessary.

8. **Temporary Lowering of Drainage Structures.** Lower drainage structures before milling the pavement.

   Record the location of the structure so each cover can be reinstalled at its original location. Remove the existing frames and covers and match mark them for later identification and placement. Salvage and safely store frames and covers. Repair the existing structure to allow uniform contact of the steel plate to the top of the structure. Place and compact the HMA for patching in accordance with section 501.

9. **Protection during Construction.** Install inlet protection devices in accordance with section 208 and as approved by the Engineer when working around the drainage structure.

B. **Drainage Structure Covers.** Provide and install new covers, including frames and grates, on new or existing structures as required. Place castings on a full mortar bed.

C. **Adjusting Drainage Structure Covers.** Adjusting drainage structure covers applies when the new elevation of the cover requires a vertical change of no greater than 6 inches. Before placing the HMA top course or overlay, make final adjustments to drainage structure covers within the HMA pavement section if only applying one course. Adjust the cover to the required elevation by supporting it on one of the following:

   1. Metal ring adjustor;

   2. Precast concrete adjusting ring;

   3. Masonry in a full mortar bed; or

   4. Alternate adjustor selected from the Qualified Products List.

Hold adjusted covers in place. Remove and replace the adjacent pavement, curb, or curb and gutter to match the existing grades or the required new elevations.

D. **Additional Depth of Adjusting Drainage Structures.** Additional depth of adjusting drainage structure covers applies when a drainage structure cover is adjusted more than 6 inches from the existing cover elevation due to a change in elevation of the roadway or when alterations to the drainage structure exceed 6 inches regardless of the change in cover elevation. Remove damaged or unsound portions of the structure as directed by the Engineer and adjust as required.

E. **Drainage Structure Taps.** Make connections to existing drainage structures owned by counties, municipalities, or drain commissions in accordance with the owner's regulations and the contract. If a conflict exists between the owner's regulations and these specifications, the owner's requirements take precedence.

If tapping an existing drainage structure, cut an opening into the receiving structure at least equal to the outside diameter of the inlet pipe plus 6 inches and insert the pipe. Pack a layer of mortar at least 3 inches thick around the inlet pipe and strike smooth with the inner wall of the receiving structure. Repair or replace existing drainage structure damaged by Contractor operations during tapping at no additional cost to the Department.

Tap directly to a sewer or culvert in accordance with subsection 402.03.D.

F. **Cleanout.** Maintain catch basins, manholes, leaching basins, and inlets installed on the project. Ensure that installed catch basins, manholes, leaching basins, and inlets are free of silt, debris, and other deleterious material at the time of final acceptance.

G. **Cleaning Existing Drainage Structures and Leads.** Before the Contractor starts work, the Engineer will determine the condition and identify the areas on the project that require cleaning of existing drainage structures and leads.

First, clean the downstream drainage structure nearest the trunk sewer and place a temporary bulkhead so the trunk sewer remains clear. Clean upstream drainage structures and leads only after cleaning and bulkheading the downstream drainage structure.

Clean the drainage structures and leads of sand, silt, and debris and prevent further contamination of the leads.

Dispose of the waste generated from the drainage structure or drainage structure lead cleanout operation using either Disposal Alternative A or Disposal Alternative B in accordance with this subsection.

If the Contractor suspects the waste generated is non-hazardous contaminated material or hazardous contaminated material, notify the Engineer. If testing shows the material is a hazardous waste as defined in Part 111, Hazardous Waste Management, of the Natural Resources and Environmental Protection Act (Michigan Compiled Laws [MCL] 324.11101 et seq.), immediately notify the Engineer.

1. **Disposal Alternative A**

   a. **Solid Waste Phase.** Solid waste disposal rules require that the waste have no releasable liquids. Dispose of the solid waste at a Type II landfill. The landfill may require testing before accepting the waste. Provide disposal documentation from the Type II landfill to the Engineer.

   b. **Liquid Waste Phase.** Dispose of the liquid waste using one of the following options:

      Option 1 – Evaporate the liquid waste by use of drying beds, decanting stations, or similar systems that contain the solids during evaporation.

      Option 2 – Place liquid waste in a sanitary sewer system with the sanitary sewer owner's approval. Provide a copy of the owner's approval to the Engineer.

      Option 3 – Pump the majority of clear liquid from the drainage structure and leads without disturbing the solids. Discharge the clear liquid to:

      i. A sanitary sewer or combined sanitary and storm system with the sewer owner's approval;

      ii. The curb and gutter such that it re-enters and is completely contained within the storm sewer system and does not directly discharge into the waters of the state; or

      iii. An area of undisturbed, well-vegetated ground at a rate that does not result in excessive ponding, runoff, or soil erosion.

      Dispose of the remaining solid and liquid phase as waste using Disposal Alternative A, either Option 1 or Option 2, or Disposal Alternative B.

2. **Disposal Alternative B.** Use a Licensed Liquid Industrial Waste Hauler to transport the waste generated and dispose of it in

accordance with Part 121, Liquid Industrial By-Products, of the Natural Resources and Environmental Protection Act (MCL 324.12101 et seq.). Provide the Engineer with a copy of the transport manifest.

403.04. Measurement and Payment

Pay Item	Pay Unit
Dr Structure, __ inch dia	Each
Dr Structure, Add Depth of __ inch dia, 8 foot to 15 foot	Foot
Dr Structure, Add Depth of __ inch dia, more than 15 foot	Foot
Drop Inlet, Type __	Each
Mh, Precast Tee, Cl __, __ inch	Each
Mh Base, __ inch, Type __	Each
Mh Riser	Foot
Dr Structure Cover, Type __	Each
Dr Structure Cover, Adj, Case __	Each
Dr Structure, Adj, Add Depth	Foot
Dr Structure, Tap, __ inch	Each
Dr Structure, Temp Lowering	Each
Dr Structure, Cleaning	Each
Dr Structure Lead, Cleaning, __ inch	Foot

A. **Drainage Structures Excluding Drop Inlets.** The Engineer will measure the depth of drainage structures, with the exception of drop inlets, from the top of the masonry to the top of the concrete footing.

The unit price for **Dr Structure** of the diameter required includes the cost of concrete footing and no greater than 8 feet of the drainage structure depth. The unit price for **Dr Structure** includes the cost of temporary or final grade adjustments of the structure.

The unit price for **Dr Structure, Add Depth, 8 foot to 15 foot** of the diameter required includes the cost of drainage structure portions greater than 8 feet deep but no greater than 15 feet deep.

The unit price for **Dr Structure, Add Depth, more than 15 foot** of the diameter required includes the cost of drainage structure portions greater than 15 feet deep.

The unit price for new structures includes the cost of cleaning new drainage structures.

B. **Drop Inlets.** The Engineer will measure drop inlets as units, of the type required, regardless of depth.

The Department will pay separately for pipe leading from the drop inlet to a sewer or catch basin. The cost of pipe from drop inlets, Type 1, is included in the unit price for related sewer pay items in accordance with

subsection 402.04. The cost of pipe from drop inlets, Type 2, as shown in the special detail, is included in the unit price for the related sewer pay item.

The Department will pay for a sewer tap or drainage structure tap in accordance with subsection 402.04 only if tapping the sewer or encased sewer into an existing drainage system is required.

C. **Manhole Base and Riser.** The Engineer will measure **Mh Riser** vertically from above the collar of the **Mh, Precast Tee** or above the **Mh Base** to the top of the riser.

The unit price for **Mh Base, Type 1** includes the cost of cutting access holes in the sewer.

If the Contractor uses **Mh Base, Type 1** in place of **Mh, Precast Tee,** and the contract does not include the pay item **Mh Base, Type 1**, the unit price for **Mh, Precast Tee** includes the cost of installing a Type 1 manhole base.

D. **Drainage Structure Covers.** When new covers are placed on existing structures, the Engineer will measure and the Department will pay for **Dr Structure Cover, Adj, Case __** in addition to the new cover.

The unit price for **Dr Structure Cover, Adj, Case 1** includes the cost of the following:

1. Sawcutting existing pavement, curb, and curb and gutter;
2. Adjusting the cover up or down no greater than 6 inches; and
3. Removing and replacing pavement adjacent to the adjusted cover in accordance with the *MDOT Standard Plan R-37* series.

The Department will pay separately for removing and replacing curb and gutter adjacent to the adjusted structure.

The Department will pay only for **Dr Structure Cover, Adj, Case 2** for structure adjustments located outside existing pavement, curb, and curb and gutter.

The unit price for **Dr Structure Cover, Adj** of the case required includes the cost of repairs for uniform contact of temporary steel plate to the top of structures.

The Engineer will measure **Dr Structure, Adj, Add Depth** of the required diameter and depth beginning 6 inches from the level of the existing structure, in the direction of adjustment, to the limit of the additional adjustment depth. If the contract includes a pay item for **Dr Structure, Adj, Add Depth,** the contract will also include a pay item for **Dr Structure**

Cover, Adj of the case required. The unit price for **Dr Structure, Adj, Add Depth** includes the cost of drainage structure taps within the limits of the adjustment.

The Department will pay for drainage structure taps outside the limits of the adjustment as **Dr Structure, Tap**. The Department will pay for taps to existing sewers as **Sewer Tap** of the size required, in accordance with subsection 402.04.

E. **Drainage Structure, Temporary Lowering.** The unit price for **Dr Structure, Temp Lowering** includes the cost of the following:

1. Match marking;
2. Removing, salvaging, and transporting castings to and from the site;
3. Storing the existing structure castings;
4. Plating the structure;
5. HMA patching; and
6. Removing the plate and HMA patching materials for final adjustment.

The Department will pay separately for the final adjustments to drainage structures. The unit price for **Dr Structure Cover, Adjust, Case 1** includes the cost of removing pavement to lower the structure.

The cost of repairs is included in the unit price for the related drainage structure adjustment pay item.

F. **Cleaning Existing Drainage Structures and Leads.** The unit price for **Dr Structure, Cleaning** includes the cost of testing for disposal, hauling, and disposing of generated waste.

The unit price for **Dr Structure Lead, Cleaning** of the size required includes temporary bulkheads and the cost of testing for disposal, hauling, and disposing of generated waste.

The cost for cleaning out existing sewers, plugged by Contractor operations, is included in related pay items.

If not included in the contract, the Department will pay for disposal of non-hazardous contaminated material and hazardous contaminated material in accordance with subsection 109.05.

Section 404. Underdrains

404.01. Description

This work consists of constructing and installing underdrains, foundation underdrains, and underdrain outlets.

404.02. Materials

Provide materials in accordance with the following sections:

A. **Pipe.** Provide geotextile-wrapped perforated pipe and tubing for underdrains, except if using with open-graded backfill material. Provide non-perforated pipe and tubing not wrapped with geotextile for underdrain outlets. Provide the following slot or hole size and water inlet area for pipe if using steel furnace slag for open-graded drainage course.

Table 404-1:
Pipe Opening Sizes for Steel Furnace Slag Open-Graded Drainage Course

Opening Type	Size
Slot width	$^{1}/_{16}$ – ⅛ inch
Hole diameter	⅛ – $^{3}/_{16}$ inch
Water inlet area (min)	2 in²/ft of tubing

B. **Aggregate for Trench Backfill.** Provide open-graded aggregate 34R to backfill the trench for open-graded underdrain. Provide granular material Class II AA as backfill for other underdrains and underdrain outlets.

C. **Outlet Endings.** Provide a concrete ring, steel end section, or concrete end section for the outlet ending.

404.03. Construction

The plans will show the locations for underdrain and underdrain outlets or will establish a miscellaneous quantity of pipe for use on the project. The plans will show, or the Engineer will determine, the line and grade of the

underdrain. Place the outlets at the intervals shown on the plans and ensure that the outlets drain.

A. **Trench Excavation.** Excavate underdrain trenches using a wheel or chain trencher or other trenching method approved by the Engineer. Grade trench bottoms to the shape of the underdrain pipe. Line trenches for open-graded underdrains with geotextile blanket as required.

B. **Laying Underdrains.** Place the underdrains to the line and grade shown on the plans or established by the Engineer. Ensure a firm bearing along the length of the pipe. Place compatible end caps on the upgrade ends of the underdrain pipes. Remove and re-lay damaged or displaced pipe.

C. **Connections.** Select fittings and connection methods in accordance with the underdrain system manufacturer's recommendations to prevent pipe separation.

   Do not penetrate the inside diameter of the pipe with the self-tapping screws by more than ⅛ inch. Wrap fittings with geotextile blanket and seal the geotextile to the outlet pipe with waterproof tape.

D. **Backfill and Compaction.** Place backfill in trenches after the Engineer approves the underdrain line and grade.

   1. **Foundation, Bank, Subbase and Subgrade Underdrains, and Underdrain Outlets.** Backfill using granular material Class IIAA.

      Place the granular material around the pipe to cover the drain with at least 12 inches of material. Place the remaining backfill in layers no greater than 12 inches. Compact the trench backfill material within the influence of the roadbed to 95% of the maximum unit weight. Compact trenches outside the roadbed as directed by the Engineer.

      If the contract calls for open-graded subgrade underdrain and open-graded bank underdrain, place the open-graded aggregate 34R as shown on the plans for open-graded underdrains.

   2. **Open-Graded Underdrains.** Backfill pipe with open-graded aggregate 34R. After placing the backfill, compact the backfill and the surrounding grade material with a vibrating plate compactor. Begin compaction along the shoulder side of the underdrain and progress toward the pavement. Do not operate the compactor directly above the underdrain.

      Maintain the exposed underdrain and backfill to prevent contamination.

      Remove and replace contaminated backfill material as determined by the Engineer at no additional cost to the Department. Clear obstructed

underdrain as determined by the Engineer at no additional cost to the Department.

E. **Underdrain Outlet.** Lay underdrain outlets on at least a 4% grade and install the underdrain outlet at least 4 inches above the receiving ditch or sewer flow line. The Engineer may waive the percent grade requirement if determining that it is not practical to meet both the percent grade and the outlet elevation requirements. Connect underdrain outlet pipe to the underdrain in accordance with *MDOT Standard Plan R-80 series*. The use of wyes, tees, or other similar fittings is not acceptable. Do not backfill the outlet trench until approved by the Engineer. Install underdrain outlets within 48 hours of installing adjoining longitudinal underdrains. Mark and maintain the outlets until final acceptance of the work.

F. **Outlet Endings.** Place the outlet endings as shown on the plans or as directed by the Engineer. Install drainage marker posts in accordance with subsection 401.03.F.

Mark the locations of outlet endings on the adjacent shoulder if installing underdrains in conjunction with constructing or resurfacing concrete or HMA shoulders. Mark locations with a ½-inch-deep, 4- by 6-inch depression. Place the long edge of the depression perpendicular to the edge of the shoulder. The Engineer may approve the following alternative methods of marking locations:

1. Stencil markers in concrete shoulders after texturing.
2. Form markers in HMA shoulders during finish rolling. Obtain the Engineer's approval of forming method prior to beginning work.

G. **Cleanout.** Ensure that installed underdrains and outlets are free of silt, debris, and other deleterious material at the time of final acceptance.

H. **Video Inspection of Underdrains.** The Department will perform video inspection of underdrains, underdrain outlets, and outlet endings after installation is complete.

The Department will perform video inspections of open-graded underdrains after the mainline pavement placement is complete but before shoulder paving.

Submit a log detailing the locations of the drain outlets installed on the project to the Engineer. In the drain outlet log, include locations of bank drain outlets, subgrade and subbase underdrain outlets, and open-graded underdrain outlets.

1. **Deficiencies.** Corrective action, including excavating and repairing or removing and replacing the underdrain or underdrain outlets, will be required if video inspection reveals any of the following deficiencies:

a. Crushed pipe;

b. Separated joints,

c. Plugged underdrain or underdrain outlet pipe;

d. Standing water greater than half the pipe diameter for greater than 25 feet; or

e. Other defects in materials or workmanship as determined by the Engineer.

2. **Corrective Action.** Obtain approval from the Engineer for the repair or removal and replacement method before beginning corrective action. Complete corrective action within 10 working days of video inspection completion or other date as approved by the Engineer.

   Complete the following corrective action at no additional cost to the Department:

   a. Excavate;

   b. Repair or remove and replace defective underdrain, underdrain outlets, and outlet endings;

   c. Backfill excavated areas;

   d. Replace and compact overlying fill, aggregate base separator course, and open-graded drainage course materials;

   e. Replace geotextile separator as required; and

   f. Replace finished shoulder or pavement material in accordance with the contract.

404.04. Measurement and Payment

Pay Item	Pay Unit
Underdrain, Subgrade, __ inch	Foot
Underdrain, Bank, __ inch	Foot
Underdrain, Subgrade, Open-Graded, __ inch	Foot
Underdrain, Bank, Open-Graded, __ inch	Foot
Underdrain, Fdn, __ inch	Foot
Underdrain, Subbase, __ inch	Foot
Underdrain, Pipe, Open-Graded, __ inch	Foot
Underdrain, Edge of Pavt, __ inch	Foot
Underdrain Outlet, __ inch	Foot
Underdrain, Outlet Ending, __ inch	Each

A. **General.** The Engineer will measure underdrains in place.

The Engineer will measure **Underdrain Outlet**, of the size required, in place from the underdrain to the center of a drainage structure or from the underdrain to the end of the outlet pipe. In addition to work specified for individual pay items, the unit prices for the relevant underdrain and underdrain outlet pay items include the cost of the following:

1. Excavating the trench;
2. Providing and placing the pipe and fittings;
3. Providing, placing, and compacting the backfill material; and
4. Disposing of surplus material excavated from the trench.

The Department will not consider claims for additional compensation for time required to repair or remove and replace deficient underdrain, underdrain outlets, and overlying materials.

B. **Subgrade, Bank, Foundation, and Subbase Underdrains**. The unit prices for **Underdrain, Subgrade**; **Underdrain, Bank**; **Underdrain, Fdn**; and **Underdrain, Subbase** of the sizes required include the cost of providing the pipe and fittings with a geotextile wrap.

C. **Underdrain, Pipe, Open-Graded.** The unit price for **Underdrain, Pipe, Open-Graded** of the size required includes the cost of providing and lining the trench with geotextile blanket.

D. **Underdrain Outlet.** The unit price for **Underdrain, Outlet** of the size required includes the cost of the following:

1. Locating installed outlets;
2. Maintaining the end of the outlet pipe or end section clear of obstructions; and
3. Providing and installing temporary tie-downs.

E. **Underdrain, Outlet Ending.** The unit price for **Underdrain, Outlet Ending** of the size required includes the cost of the following:

1. Excavating the area at the end of the outlet;
2. Providing and placing the concrete ring, steel end section, or concrete end section; and
3. Disposing of surplus excavated material.

The Engineer will measure and the Department will pay for pipe or tubing used in or through the outlet ending as **Underdrain Outlet**. The unit price

for **Underdrain, Outlet Ending** includes the cost of marking the outlet ending locations on the adjacent shoulder.

The Engineer will measure and the Department will pay for drainage marker posts in accordance with subsection 401.04.

Section 501. Plant-Produced Hot Mix Asphalt

501.01. Description

This work consists of providing and placing hot mix asphalt (HMA) mix using Superpave mixture design methods.

A. **Definitions**

Binder Content. Percent by weight of asphalt cement in the total mixture.

Broken Aggregate. Cracked aggregate caused by construction operations.

Bulk Specific Gravity of Aggregate (G_{sb}). Ratio of the oven dry weight in air of a unit volume of an aggregate at a stated temperature to the weight of an equal volume of water at a stated temperature.

Crack. Visible fissure of varying length and orientation in the HMA, partially or completely through at least one course.

Effective Specific Gravity (G_{se}). Ratio of the oven dry weight in air of a unit volume of an aggregate (excluding voids permeable to asphalt) at a stated temperature to the weight of an equal volume of water at a stated temperature.

Flushing. Shiny or reflective condition, tacky to the touch, appearing on the HMA surface when asphalt binder collects in the voids at high pavement temperatures.

HMA Mix Design. Selection and proportioning of aggregates, mineral filler, reclaimed asphalt pavement (RAP), and asphalt binder to meet the required mix design criteria.

HMA Segregation. Areas of HMA pavement exhibiting non-uniform distribution of coarse and fine aggregate particles, visually or otherwise identifiable.

Job Mix Formula (JMF). HMA mix for a specific project, including adjustments to optimize the field application.

Lot. A lot is made up of a discrete tonnage of one mixture. A lot typically has five sublots (see definition of “sublot”).

Maximum Specific Gravity of Mixture (G_{mm}). Ratio of the weight in air of a unit volume of an uncompacted HMA at a stated temperature to the weight of an equal volume of water at a stated temperature.

Pavement. Completed HMA placement, including layers on driving lanes and shoulders.

Pavement Edge. Extremity boundaries of the pavement.

Roller Cracking. High-density surface map-cracking that appears immediately after rolling.

Rutting. Depression or displacement of the HMA surface that occurs in a longitudinal direction or a localized area.

Quality Assurance (QA). All activities dealing with acceptance of the product, including but not limited to materials sampling, testing, construction inspection, and review of Contractor quality control (QC) documentation. The Engineer's HMA QA procedures are contained in MDOT's *HMA Production Manual* and MDOT's *HMA QA Plan*.

Quality Control (QC). All activities dealing with process control to ensure quality, including but not limited to training, materials sampling, testing, project oversight, and documentation. For example, the Contractor's HMA QC procedures are contained in the Contractor's *HMA QC Plan*.

Sublot. Portion of a lot or an individual sample that is represented by a complete set of QA tests. Sublots are approximately equal in size at 1,000 tons. The Contractor and the Engineer may agree to reduce the typical 1,000-ton sublots based on project staging or other project conditions.

Target Value. JMF parameter value that may be adjusted, if approved by the Engineer, to account for changes in the physical properties of the mixture.

Temporary Pavement. Roadway and appurtenances constructed to help the movement of highway and pedestrian traffic around a construction operation that will be removed upon completion of the project.

Unlimited Daily HMA Production. Unrestricted daily HMA production tonnage.

Voids in Mineral Aggregate (VMA). Volume of void space between the aggregate particles of a compacted paving mixture that includes the air voids and the asphalt binder not absorbed into the aggregate, expressed as a percentage of the total volume of mixture.

501.02. Materials

Provide materials in accordance with the following sections:

Plant-produced HMA consists of asphalt binder, aggregates, mineral filler, and other additives.

Provide release agents that do not harm the HMA mixture. Do not use fuel oil or other distillate derivatives.

Provide the HMA mix type and the performance grade of asphalt binder as required by the contract.

Provide blended aggregates for HMA top course mixtures, except top courses for shoulders, bike paths, temporary roads, and parking areas, meeting the required Aggregate Wear Index (AWI).

A. Composition of HMA Mixtures

1. **Mix Design.** Develop an HMA mix design in accordance with the *HMA Production Manual* and submit to the Department. The Department will evaluate the design in accordance with Section 1 of the *HMA Production Manual*, “Procedures for HMA Mix Design Processing.”

   Provide written certification that the materials in the mix design are from the same source and meet the material properties in the mix design or the Department-approved JMF. Make all JMF adjustments in accordance with the *HMA Production Manual*.

   Provide combined aggregate blends meeting the properties specified in section 902. Provide a mix design that meets the requirements in Table 501-1, Table 501-2, and Table 501-3.

   For mix design purposes, top and leveling courses are the mix layers within 4 inches of the surface. The base course consists of the layers below 4 inches from the surface. For mix layers within the 4-inch threshold, if less than 25% of the mix layer is within 4 inches of the surface, the mix layer is a base course.

Table 501-1: Superpave Mix Design Criteria

Design Parameter	Mix Number			
	5	4	3	2
Percent of maximum specific gravity (%G_{mm}) at the design number of gyrations (N_d)	96.0%[(a)]			
%G_{mm} at the initial number of gyrations (N_i)	See Table 501-3			
%G_{mm} at the maximum number of gyrations (N_m)	≤98.0%			
Voids in mineral aggregate (VMA) min % at N_d (based on aggregate bulk specific gravity (G_{sb}))	15.00	14.00	13.00	12.00
Voids filled with asphalt (VFA) at N_d	See Table 501-2[(b)]			
Fines to effective asphalt binder ratio (P_{No200}/P_{be})	0.6–1.2			
Tensile strength ratio (TSR)	80% min			

(a) Unless noted otherwise on the plans, design all mixtures to 96.0% of maximum specific gravity (%G_{mm}) at the design number of gyrations (N_d). During field production, increase percent of maximum specific gravity (%G_{mm}) at the design number of gyrations (N_d) to 97.0%. Use liquid asphalt cement for regression of mixes unless otherwise noted on plans.

(b) For regressed mixtures the maximum criteria limits do not apply.

Table 501-2:
VFA Minimum and Maximum Criteria

Estimated Traffic (million ESAL)	Mix Type	Top and Leveling Courses	Base Course
≤0.3	EL	70–80%	70–80%
>0.3 – ≤3.0	EML	65–78%	65–78%
>3.0 – ≤30	EMH	65–78%[(a)]	65–75%
>30 – ≤100	EH	65–78%[(a)]	65–75%

ESAL = equivalent single-axle load

(a) The specified VFA range for mix Number 5 is 73–76%.

Table 501-3:
Superpave Gyratory Compactor Compaction Criteria

Estimated Traffic (million ESAL)	Mix Type	%G_{mm} at (N_i)	Number of Gyrations[(a)]		
			N_i	N_d	N_m
≤0.3	EL	≤91.5%	7	50	75
>0.3 – ≤3.0	EML	≤90.5%	7	75	115
>3.0 – ≤30	EMH	≤89.0%	8	100	160
>30 – ≤100	EH	≤89.0%	9	125	205

ESAL = equivalent single-axle load

(a) Compact mix specimens fabricated in the Superpave gyratory compactor (SGC) to N_d. Use height data provided by the SGC to calculate volumetric properties at N_i. Compact mix specimens at optimum P_b (percent asphalt binder content) to verify N_m for mix design specimens only.

If high-stress HMA is shown on the plans, provide the same mix designation (5EML, 5EMH, 4EML, 4EMH, etc.) as required for the

mainline top and leveling courses, except change the performance-graded (PG) binder as shown on the HMA application table.

2. **Recycled Mixtures**. Recycled asphalt pavement (RAP) may be substituted for a portion of the new material required to produce the HMA mixture. Design and produce the mix to meet the criteria in this subsection and the contract.

    a. **Stockpile Requirements.** Process RAP to the size required for the specified HMA mix. Ensure the stockpile contains enough material to produce the recycled mixtures the Engineer approves for the project. If the RAP stockpile is not sufficient to produce recycled mix quantities required for the project, provide an Engineer-approved mix design without RAP at the same unit price.

    Provide documentation of testing (one test per 1000 tons, minimum of three tests) and accumulated tonnage in the stockpile to the MDOT laboratory. The tonnage may be estimated. The Department will begin evaluating the mix design after receipt of the documentation.

    b. **Mix Design.** Submit required documentation for recycled mix designs in accordance with Section 1 of the *HMA Production Manual*, “Procedures for HMA Mix Design Processing.”

B. **HMA Plant Certification.** Ensure HMA plants are certified by the Department at least 5 days before mix production begins. The Engineer will certify HMA facilities in accordance with Section 2 of MDOT’s *HMA Production Manual*, “Certification Procedure of HMA Plants.” Post a seal of certification in the plant control office.

C. **HMA Production.** Submit an approved mix design for the mix required to the Engineer at least 4 days before production begins.

Provide even heating of the mass of asphalt binders and maintain heat control. Heat asphalt binders to the temperature required for the type of binder. Do not exceed the maximum temperature specified in Table 904-8 for asphalt binder and HMA. The Department will reject asphalt binder and mix if the temperature exceeds the maximum specified in Table 904-8. The Department will reject contaminated asphalt binder.

Stockpile aggregates at the facility in a manner that prevents segregation. Dry aggregates to a moisture content that will ensure an appropriately coated HMA mix. For batch and continuous plants, the Department will reject aggregates in the hot bins that contain sufficient moisture to cause foaming or a water-saturated mixture. Remove rejected materials from the bins.

Place uniform gradations of aggregates in the cold feed system. If providing a blend of aggregates for the mix by combining aggregates from at least two cold feed bins, ensure that the blend meets the combined gradation (from JMF) QC tolerances.

The use of at least one hot aggregate bin to proportion aggregates to meet the JMF tolerances is allowed if the cold feed requirements are met.

501.03. Construction

A. **Equipment.** Provide equipment in accordance with section 107, capable of producing pavement that meets the requirements of this section.

1. **Cold-Milling Machines.** Provide equipment that consistently removes the HMA surface, in one or more passes, to the required grade and cross section, and produces a uniformly textured surface. Provide machines equipped with the following:

   a. Provide a cold-milling machine that has sufficient power, traction, and stability to maintain an accurate depth of cut. Maintain the propulsion and guidance system of the milling machine in such condition that the milling machine may be operated to straight and true lines;

   b. Provide a cold-milling machine capable of operating using minimum 30-foot automatic grade controls (contact or non-contact) averaging system or other approved grade control systems and capable of transverse slope control. Describe the use of such controls in the Contractor's *Cold-Milling Quality Control Pla*n; and

   c. Provide a cold-milling machine capable of picking up the removed material in a single operation. A self-loading conveyor will be an integral part of the milling machine. Windrows are not allowed.

2. **Hauling Equipment**. Ensure that transport trucks are equipped to protect the mix from the weather and retard the loss of heat. Equip transport trucks and trailers with a working backup alarm.

3. **Pressure Distributor**. Provide a pressure distributor in accordance with subsection 505.03.A.1.

4. **Pavers.** Equip each paver with a full-width vibratory or tamper bar screed capable of spreading and finishing HMA to the required cross section and grade. Use a paver that produces a uniformly finished surface, free of tears, other blemishes, and measurable segregation.

   Equip the paver to provide a uniform head of material ahead of the screed. Install reverse pitch augers or paddles inside the ends of the auger shafts to force the mix to the center of the main screed.

Ensure that extensions added to the main screed provide the same vibrating or tamping action and heating capabilities as the main screed. Adjust extensions to the main screed so, after breakdown rolling, no longitudinal marks remain on the surface. Equip in-line screed extensions with a continuation of the automatically controlled spreading augers to within 12 inches of the outside edge. Follow the manufacturer's recommendations for other screed extensions.

Except for the paving operations listed in subsection 501.03.F.1.a through subsection 501.03.F.1.d, equip pavers with an automatically controlled and activated screed with grade reference and transverse slope control. Use an Engineer-approved grade referencing attachment, at least 30 feet long for lower courses and the first pass of the top course. Ensure that the Engineer approves alternate grade referencing attachments before use.

After placing the first pass of the top course, the Contractor may, with prior approval from the Engineer, substitute a joint matcher, a grade referencing attachment at least 10 feet long, or other grade referencing equipment for constructing adjacent passes of the top course.

5. **Rollers**

   a. **Steel-Wheeled Rollers.** Provide self-propelled vibratory steel-wheeled rollers, static tandem rollers, or self-propelled static three-wheeled rollers. Provide a steering device that allows the roller to follow the established alignment. Equip rollers with wheel sprinklers and scrapers. Provide smooth roller wheels, free of openings or projections that will mar the pavement surface.

      Provide vibratory rollers with an automatic shutoff to deactivate the vibrators if the roller speed decreases below ½ mph. Provide rollers that operate in accordance with the manufacturer's recommended speed, impacts per foot, and vibration amplitude for the thickness of HMA mix.

   b. **Pneumatic-Tired Rollers.** Provide self-propelled pneumatic-tired rollers. Equip rollers with at least seven wheels spaced on two axles so the rear group of tires does not follow in the tracks of the forward group, providing at least ½-inch tire path overlap. Provide smooth tires capable of being inflated to the pressure recommended by the roller or tire manufacturer. Equip the rollers

with a mechanism that can smoothly reverse the motion of the roller.

Equip the rollers with wheel scrapers and skirting to enclose the wheels to within 3 inches of the pavement surface. Use a release agent to prevent material from sticking to the tires and being deposited on the top course pavement during rolling.

c. **Combination Rollers**. The Contractor may use combination pneumatic-tired and steel-wheeled rollers manufactured specifically for HMA compaction, if equipped with the required sprinklers and scrapers.

6. **Spreaders**. Use self-propelled spreaders capable of pushing the hauling units. Ensure that spreaders can maintain the required width, depth, and slope, without causing segregation.

7. **Material Transfer Device**. When a material transfer device (MTD) is required, it must be capable of delivering HMA mix from the truck transport to the paver hopper to ensure constant paver speed, remixing HMA material using manufacturer's developed technology, and depositing material in the paver hopper. Provide a paver hopper insert with at least a 10-ton capacity in the paver and keep at least two-thirds full of mix during paving. A windrow pickup machine does not satisfy the requirements for an MTD.

8. **Compressed Air System**. If a compressed air system is required for cleaning pavement, equip the air compressor with a moisture separator to remove oil and water from the air supply. Provide a compressor capable of producing at least 100 psi and continuous 150 cfm airflow.

9. **Miscellaneous Equipment**. Provide a straightedge, at least 10 feet long, and other tools to finish the work.

10. **Lights on Equipment**. If maintaining traffic on HMA construction, equip equipment within the project, including cold-milling machines, distributors, and rollers, with at least one Department-approved flashing, rotating, or oscillating amber light. Equip pavers with at least one light on each side. Mount the lights so the warning signal is visible to traffic in every direction. Operate the lights while work is in progress. Ensure that hauling units activate four-way flashers on the project.

B. **Preparation of Base.** Provide subgrade, subbase, aggregate base course, crushed and shaped base, or rubblized base in accordance with the relevant sections of Division 2 and Division 3, before HMA placement.

C. **Preparation of Existing Pavement.** Prepare the existing surface as required to construct HMA pavements, shoulders, and approaches.

1. **Drainage Structures, Monument Boxes, and Water Shutoffs**. Adjust, temporarily lower, or both, catch basins, manhole covers, monument boxes, and water shutoffs in accordance with subsection 403.03.A. Meet the smoothness requirements required in subsection 501.03.H.

2. **Cleaning Pavement.** Using methods approved by the Engineer, clean dirt and debris from the pavement surface and paved shoulders before placing HMA. Remove loose material from joints and cracks using compressed air.

   If the Engineer determines the compressed air system will not remove deleterious material, remove loose material by a hand or mechanical method, as approved by the Engineer. The Department will pay for removal of material by hand or mechanical methods in accordance with subsection 501.04.E.

   Do not place HMA until the Engineer inspects and approves the condition of the existing pavement.

3. **Removing Existing Pavement for Butt Joints**. If a butt joint is required, remove the existing surface to the thickness of the proposed overlay for the full width of the joint. Uniformly taper the removal to the original surface over at least 35 feet.

4. **Edge Trimming**. For required removal of HMA shoulder material or no greater than 1 foot width of HMA pavement, cut the HMA material full depth along the pavement edge or removal line to prevent tearing the pavement surface. Cut joints, where the completed surface will be exposed, with a saw, cold-milling machine, or other methods approved by the Engineer. Cut joints, where the completed surface will be covered by HMA mix, with a coulter wheel, saw, cold-milling machine, or other method approved by the Engineer.

5. **Cold-Milling HMA Surfaces.** Before milling existing pavement, obtain a Department-approved mix design in accordance with subsection 501.02.A, and ensure the availability of HMA mix quantities to cover milled surfaces. Do not maintain traffic on the milled surface unless specified in the contract or approved by the Engineer.

   Cold-Milling QC Plan and Cold-Milling Operations Plan. Prior to beginning milling operations, submit a *Cold-Milling QC Plan* and a *Cold-Milling Operations Plan* to the Engineer for approval.

a. Include, as a minimum, the following items in the *Cold-Milling QC Plan*:

   i. The schedule for replacing the cutting teeth;

   ii. The daily preventive maintenance schedule and checklist;

   iii. Proposed use of automatic grade controls;

   iv. The surface testing schedule for smoothness;

   v. The process for filling distressed areas;

   vi. The schedule for testing macrotexture of the milled surface;

   vii. Corrective procedures if the milled surface does not meet the minimum macrotexture specification;

   viii. Corrective procedures if the milled surface does not meet the minimum transverse or longitudinal surface finish when measured with a 10-foot straightedge;

   ix. The methods for longitudinal control guidance (painted string line or measure offs); and

   x. Contact information for on-site contractor personnel responsible for the work and authorized to adjust the QC plan.

b. Include, as a minimum, the following specific items in the *Cold-Milling Operations Plan*:

   i. Number, types, and sizes of mill machines to be used;

   ii. Width and location of each mill machine pass;

   iii. Number and types of brooms and or vacuum trucks to be used and their locations with respect to the mill machine;

   iv. Proposed method for mill machine and wedging around existing structures such as manholes, valve boxes, and inlets;

   v. Longitudinal and transverse typical sections for tie-ins at the end of the day;

   vi. If requested by the Engineer, a plan sheet showing the milling passes; and

   vii. Names of macro-texture testing personnel and sequencing of testing (minimum of three tests daily that are representative of the day's milling).

   Remove the HMA surface to the depth, width, grade, and cross section shown on the plans. Backfill and compact depressions

resulting from removal of material below the specified grade, in accordance with subsection 501.03.C.9.

If the milling machine discovers buried structures within the specified grade, such as valve boxes, manholes, or railroad tracks that are not identified on the plans, the Department will pay for all associated costs, as extra work, in accordance with subsection 103.02.

Immediately after cold-milling, clean the surface. Dispose of removed material in accordance with subsection 104.07.D and subsection 204.03.

Mill the existing pavement to the cross slope shown on the plans. Supply a 10-foot straightedge. Ensure that the finished surface does not vary longitudinally or transversely more than ¼ inch from a 10-foot straightedge. Ensure that the milled area is free from gouges, continuous grooves, and ridges and has a uniform texture. Ensure that the horizontal gouge in the vertical edge created from the milling operation is limited to a maximum width of 1.0 inch. Adjust speed, drum speed, and/or teeth as necessary to meet the requirements of this specification. Ensure that the milling operation provides an acceptable surface texture by achieving a maximum mean texture depth of 0.108-inch thickness according to ASTM E965. Perform three random QA macro texture tests daily that are representative of the day's milling to maintain texture and verify conformance with the 0.108-inch thickness mean texture depth requirement. For projects with less than 3,000 square yards, a minimum of one random QA macro texture test per day is required. Perform tests as soon as practical behind the milling operations.

6. **Removing HMA Surface.** Except as specified in subsection 501.03.C.4, removing an HMA surface applies to removing HMA overlying a material designated for removal or that is required to remain in place.

   Cut joints, exposed in the completed surface, with a saw or cold-milling machine. Cut joints, covered by HMA mix, with a coulter wheel, saw, or cold-milling machine. Obtain the Engineer's approval of alternate methods for cutting joints.

   When removing HMA overlying a base course that is to remain in place, cut the edges of the surface requiring removal along straight lines for the full depth of the HMA surface.

When removing HMA by cold-milling, the Engineer may direct removal to be less than the full depth of HMA surface.

7. **Removing HMA Patches**. Remove patches that may compromise the performance of the overlay.

8. **Joint and Crack Cleanout**. If the plans show joint and crack cleanout, use mechanical or hand methods to remove joint sealants to at least 1 inch deep. Remove vegetation, dirt, and debris that cannot be removed using the methods specified in subsection 501.03.C.2 from transverse and longitudinal joints and cracks. Use hand patching to fill cleaned joints and cracks at least 1 inch wide.

9. **Hand Patching**. If the contract requires hand patching, fill holes, depressions, joints, and cracks in the existing pavement and replace existing patches. Compact the hand patching material in no greater than 3-inch layers to the adjacent pavement surface grade using a machine vibrator or Department-approved roller. Use top course or other Engineer-approved mix for hand patching material.

10. **Repairing Pavement Joints and Cracks**. Repair joints and cracks as required.

D. **Bond Coat.** Uniformly apply the bond coat and provide complete coverage to a clean, dry, surface with a pressure distributor. Obtain the approval of the Engineer for the application rate after work begins. Application rate must be within a range of 0.05 to 0.15 gallons per square yard. Apply the bond coat ahead of the paving operation to allow the bond coat to cure before placing HMA.

Do not leave pools of bond coat on the surface and do not spray the bond coat on adjacent pavement surfaces. Apply the bond coat to each HMA layer and to the vertical edge of the adjacent pavement before placing subsequent layers.

E. **Transportation of Mixtures.** Weigh each load of HMA, accepted by the Department, to the nearest 20 pounds on an approved scale with an automatic printout system. Provide a scale and printout system for platform and suspended scales in accordance with subsection 109.01.B.6. Provide a ticket to the Engineer with each load.

Apply a release agent, in accordance with subsection 501.02, to hauling units. Loads with excessive amounts of release agent will be rejected. Do not place crusted HMA in the paver.

The Department will reject loads, immediately prior to placement, with a temperature either below 250°F (225°F when using a warm mix chemical

additive) or greater than 20°F from the recommended maximum mixing temperature specified by the binder producer.

F. **Placing HMA**

1. **General**

Place HMA on a cured bond coat using pavers in accordance with subsection 501.03.A.4 unless placing mixtures for the following:

a. Variable width sections;

b. The first course of a base course mix on a subgrade or sand subbase;

c. Base course mixtures for shoulders and widening less than 10½ feet wide; or

d. Top and leveling course mixes for shoulders and widening less than 8 feet wide.

Place HMA mix in layers, and do not exceed the application rate. If the application rate for an HMA pavement exceeds the maximum rates specified in Table 501-4 and the edges are not confined, construct the pavement in at least two layers.

Table 501-4:
HMA Application Rates

Mix Number[(a)]	Course Application	Application Rate (lb/yd²), minimum – maximum[(b)]
2	Base	435–550
3	Base, leveling	330–410
4	Leveling, top	220–275
5	Top	165–220

(a) See Table 501-1 for the mix number design parameters.
(b) Minimum application rates do not apply to wedging courses.

Wedge with HMA to remove irregularities in the existing road surface. Place and compact HMA wedging to correct the foundation. Allow the wedging to cool enough to support construction equipment without causing visible distortion of the mat before placing subsequent wedging, base, leveling, or top course mixtures.

Place HMA mix to the slope and width shown on the plans. Place subsequent HMA course to align the vertical edge with the previous courses, without constructing a ledge. Correct ledges that result from placing material in excess of the width shown on the plans at no additional cost to the Department.

Place shoulder aggregate and compact flush after placement of each layer of HMA at the end of the paving day or place traffic control devices in accordance with subsection 812.03, at no additional cost to the Department. Complete final shaping and compaction of the shoulders after placing the top course of HMA.

If delays slow paving operations and the temperature of the mat immediately behind the screed falls below 200°F, stop paving and place a transverse construction joint. If the temperature of the mat falls below 190°F before initial breakdown rolling, remove and replace the mat at no additional cost to the Department.

If placing the uppermost leveling and top course, place the longitudinal joint to coincide with the planned painted lane lines.

If the temperature of the mat falls below 170°F before placing the adjacent mat, apply bond coat to the vertical edge of the mat.

If constructing the lanes with at least two pavers in echelon, match the depth of loose HMA from each paver at the longitudinal joints.

2. **Joints in HMA Pavement**

   a. **Transverse Construction Joint.** If constructing a transverse construction joint, stop the paver and lift the screed before material falls below the auger shaft. Remove the paver and roll through the planned joint location. Cut a transverse vertical joint and remove excess HMA.

      Place burlap, canvas, or paper as a bond breaker ahead of and against the vertical face. Place HMA against the bond breaker and taper from the new mat to the existing surface. Extend the temporary taper 5 feet for each inch of mat thickness, or as directed by the Engineer. Compact and cool the temporary taper before allowing traffic on the new surface. Remove the temporary taper before resuming paving.

   b. **Feather Joint**. Transition the new mat to existing surfaces at the beginning and end of resurfacing sections and at intersections unless using butt joints. Transition the new mat to existing surfaces at a rate of 1 inch over 35 feet. Construct transitions on a cured bond coat applied at a rate of 0.10 gallon per square yard. After compaction, spray with bond coat, sand, and roll the first 3 feet of the joint and 1 foot of the existing surface.

   c. **Vertical Longitudinal Joint.** When opening to traffic, plan the work to resurface adjacent lanes to within one load of the same

ending point at the completion of paving operations each day. Construct a vertical joint to conform to the pavement cross section.

When compacting an unsupported (unconfined) edge of the mat, keep the roller from 3 to 6 inches inside the unsupported edge on the first pass; ensure that the roller overhangs the unsupported edge by 3 to 6 inches on the second pass.

When placing HMA in a lane adjoining a previously placed lane, place the mixture so that the strike-off shoe will produce an edge that is adjacent to or minimally overlaps the adjoining course. Compact the longitudinal joint by rolling from the hot side, keeping the edge of the roller approximately 6 inches to 8 inches inside the cold joint for the first pass. For the second pass of the roller, compact the joint from the hot side while overlapping the cold side by 6 to 8 inches.

d. **Tapered Overlapping Longitudinal Joint.** A tapered overlapping longitudinal joint may be used instead of a longitudinal vertical joint.

If using tapered overlapping longitudinal joints, resurfacing lanes within one load of the same point-of-ending at the completion of paving operations each day is not required. Pave adjacent lanes within 24 hours unless delayed by inclement weather or approved by the Engineer.

Construct the tapered overlapping longitudinal joint by tapering the HMA mat at a slope no greater than 1:12. Extend the tapered portion beyond the normal lane width.

Place a ½-inch to 1-inch notch at the top of the taper on paving courses.

Provide a uniform slope by constructing the tapered portion of the mat using a Department-approved strike-off device that will not restrict the main screed.

Apply bond coat to the surface of the taper before placing the adjacent lane.

3. **Placing HMA Shoulders.** Use a self-propelled mechanical paver or spreader to place HMA shoulders.

If placing the top course on new shoulders, or placing leveling, or top course on existing HMA shoulders at least 8 feet wide, place the mix using a paver with an automatically controlled and activated screed and strike-off assembly and corresponding grade referencing

equipment. Use grade-referencing equipment as directed by the Engineer.

Stop shoulder paving at crossroad approaches, auxiliary lanes, commercial driveways, and ramps. Do not pave through these areas.

4. **Placing HMA Approaches.** Place HMA on driveway or crossroad approach foundations, as approved by the Engineer.

   Place approaches in layers no greater than the application rate. Do not stop mainline paving of lanes adjacent to the approach to pave the HMA approach.

5. **Safety Edge.** Construct the safety edge on the shoulders at locations shows on the plans. The finished shape of the safety edge will be in accordance with *MDOT Standard Plan R-110* series. Ensure that the safety edge is constructed monolithically with the shoulder and is of the same material type. Prior to placing HMA shoulder overlays, prepare the existing shoulder material to provide a smooth and uniform paving surface. Excavate, trench, and/or shape the existing shoulder material so that the safety edge may be placed as required on the plans. Ensure that the existing material does not impede the paving equipment and placement of HMA. For new or reconstructed shoulders, prepare base materials in accordance with the plans.

   Use an approved longitudinal safety edge system to create a sloped edge profile onto the roadway shoulder. Use an approved safety edge system that compacts the HMA and provides a finished sloped wedge in accordance with the contract. Do not use a single plate strike off. Use a system that is adjustable to accommodate varying pavement thicknesses.

   Prior to commencing any shoulder work, provide a test section to demonstrate the safety edge finished shape and compaction of the proposed safety edge system. The Engineer may waive the test section if satisfactory evidence is provided that the proposed system has been successfully used on other MDOT or MDOT local agency projects. Ensure that all safety edge systems have been approved by the Engineer.

G. **Rolling.** Compact each layer of HMA in accordance with the contract and free of roller marks.

   Keep the surface of the steel roller wheels moist during rolling.

   Use a pneumatic tire roller on HMA overlay projects in the intermediate rolling position to knead HMA over existing pavement.

H. **Smoothness Requirements.** After final rolling, the Engineer may test the surface longitudinally and transversely using a 10-foot straightedge at selected locations in accordance with Michigan Test Method (MTM) 722. Construct the surface and correct variations, at no additional cost to the Department, to the tolerances specified in this subsection.

1. **Base Course**. Construct lower layers of base courses to a tolerance of ¾ inch and final layers of base courses to a tolerance of ⅜ inch.

2. **Leveling and Top Course**. For multiple course construction, construct lower courses to a tolerance of ¼ inch and top courses to a tolerance of ⅛ inch.

3. **Single Course Overlays**. Construct single courses to a tolerance of ¼ inch.

4. **Longitudinal Joints**. Construct adjacent lanes to a tolerance of ¼ inch for base and leveling courses and a tolerance of ⅛ inch for top courses.

5. **Drainage Structures, Monument Boxes, and Water Shutoffs**. Construct to a tolerance of ¼ inch.

I. **Weather Limitations**

1. **HMA Weather Limitations**. Place HMA in accordance with the following restrictions:

a. Do not place HMA or apply bond coat when moisture on the existing surface prevents curing;

b. Do not place HMA unless the temperature of the surface being paved is at least 35°F and there is no frost on or in the grade or on the surface being paved, unless otherwise approved by the Engineer in writing;

c. Place only HMA courses that are greater than 200 pounds per square yard if the temperature of the surface being paved is greater than 35°F;

d. Place only HMA courses that are greater than 120 pounds per square yard if the temperature of the surface being paved is at least 40°F; and

e. Place any HMA course if the temperature of the surface being paved is at least 50°F.

J. **Protection of Structures.** Protect bridges, curbs, gutters, driveways, sidewalks, barriers, and other appurtenances to prevent surfaces from becoming discolored during application of bond coat or HMA to the road

surface. Remove material from appurtenances, as directed by the Engineer, at no additional cost to the Department.

K. **Aggregate Shoulders.** On resurfacing projects, scarify existing aggregate shoulder surfaces before placing new aggregate material.

Maintain the shoulder for vehicles to pass the construction equipment. If Contractor operations or traffic disturbs the area between the pavement and the right-of-way line, restore the area to a condition approved by the Engineer at no additional cost to the Department.

L. **Monument Boxes.** Place or adjust monument boxes in accordance with section 821.

M. **Quality Control Plan.** Prepare and implement a QC plan for HMA in accordance with MDOT's *HMA Production Manual*.

Make adjustments in process controls to prevent production of non-conforming material instead of accepting payment at a reduced price. The Department will not allow continual production of non-conforming material at a reduced price instead of making adjustments.

The Engineer will not perform sampling or testing for QC or assist in controlling the HMA production and placement operations.

N. **HMA Mix Acceptance.** The Engineer will inspect field-placed material, perform QA sampling and testing, and monitor Contractor adherence to the Contractor's *HMA QC Plan*.

1. **HMA Field-Placed Inspection.** The Engineer will perform a visual inspection of HMA to identify areas requiring corrective action. The Engineer will inspect the base and leveling courses within 18 hours and the top course within 36 hours of placement. If the Engineer determines that corrective action is required, do not pave overlying courses until after corrective action is completed and the Engineer determines that the pavement is in conformance with the contract.

   The Engineer will determine the need for corrective action based on the factors specified in Table 501-5. Corrective action may include remedial treatment, including crack or surface sealing, or replacement.

   Submit an action plan to the Engineer that addresses all factors that resulted in the need for corrective action. Complete all corrective action required to repair or replace unacceptable work at no additional cost to the Department.

   If the Engineer and the Contractor agree, the Department may make a contract adjustment of no greater than 100% of the bid price for corrective action.

Table 501-5:
HMA Criteria for Corrective Action

Criterion[a]	Length	Extent[b]	Severity	Corrective Action[c]
Segregation	—	>215 ft²/ 328-foot LL	Heavy[d]	Replace
Rutting	—	>32 feet	>¼ inch average depth over the length of occurrence	Replace
Flushing	—	>108 ft²/ 328-foot LL	High[e]	Replace
Edge of paved shoulder	>33 feet	Visible ledges	>3 inches	Trim
Crack[g]	Any	Any	All	Seal[f]

LL = lane length

(a) Criteria apply to all courses except flushing, which applies to the top course only.

(b) Extent is calculated by summing locations within the required length.

(c) The appropriate corrective action depends on the extent and severity of the criteria and on the intended service life of the pavement.

(d) Segregation severity will be determined in accordance with MTM 326. If segregation thresholds are met twice on a paving course, the use of an MTD for the remaining paving for that course may be required at no additional cost to the Department.

(e) Flushing severe enough to significantly affect surface friction (Friction Number <35).

(f) Other corrective action may be required as crack frequency increases.

(g) A reflective crack determined by the Engineer to be caused by an underlying condition does not require corrective action.

The Department will not grant extensions of time for repair work to meet the inspection acceptance requirements specified in subsection 501.03.N.1.

The Engineer will determine the area subject to corrective action, for removal and replacement of top courses, as the longitudinal extent of corrective action multiplied by the width of the paving course affected.

The Department will accept HMA subject to corrective action as follows:

a. HMA placed for corrective action involving full removal and replacement will be accepted in accordance with the contract.

b. The area requiring corrective action other than full removal and replacement will not be measured for incentive payment.

c. If more than 10% of the area of a sublot requires corrective action, the sublot will not be measured for incentive payment.

2. **HMA Testing Acceptance**. The Engineer will accept HMA based on visual inspection, small tonnage, or QA sampling and testing

acceptance criteria The Engineer will notify the Contractor before conducting QA sampling to allow the Contractor to witness the sampling, but not in a manner that will allow alteration of production in anticipation of sampling. The Engineer will conduct QA sampling in accordance with MTM 313 or MTM 324.

a. **Visual Inspection Acceptance Criteria**. The Engineer may accept quantities less than 500 tons, of any individual mixture, in accordance with MDOT's *Materials Quality Assurance Procedures (MQAP) Manual*.

b. **Temporary Pavement Acceptance Criteria.** The basis for measuring the mixture quality is QC testing and the QC processes specified in the applicable contract specifications for Superpave or Marshall mixes. Provide a copy of QC result to the Department within 24 hours upon request. The Department is not required to perform QA testing for the temporary HMA but reserves the right to perform verification testing. All materials and HMA mixture requirements apply. The initial production lots will be waived upon request. There are no pay factor or price adjustments based on mixture volumetrics for the temporary HMA.

   Perform all maintenance with the exception of snow and ice removal during the seasonal shutdown period. Maintain temporary pavement until the completion of the contract or the opening to traffic of the new pavement.

   Correct all deficiencies with the temporary pavement. The Engineer will make a negative adjustment for deficiencies requiring repairs or renewals, not corrected within the time frames stated in section 812 and for each occurrence that maintenance is required on the temporary HMA. Contract price adjustments will be made, according to Table 501-6, for each occurrence that repairs or renewals are required on the temporary roadway that are not attributable to normal wear and tear of traffic, weather, or an inadequate base condition not addressed in the contract.

O. **Asphalt Binder Acceptance.** The Department will accept asphalt binder in accordance with Department procedures.

Table 501-6:
Contract Adjustments for Maintenance of Temporary Pavement

ADT[a]	Per Maintenance Occurrence
0–10,000	$2,000[b]
10,000–40,000	$4,000[b]
≥40,000	$8,000[b]

(a) Based on average daily traffic (ADT) shown on Title Sheet

(b) The contract adjustment will be doubled if the Contractor 's *HMA-QC Plan* is not adhered to.

501.04. Measurement and Payment

Pay Item	Pay Unit
HMA, 5 E __	Ton
HMA, 4 E __	Ton
HMA, 3 E __	Ton
HMA, 2 E __	Ton
HMA, (type), High Stress	Ton
HMA Approach	Ton
HMA Approach, High Stress	Ton
HMA, Temp Pavt (mix type)	Ton
Pavt for Butt Joints, Rem	Square Yard
Edge Trimming	Foot
Cold Milling HMA Surface	Square Yard, Ton
HMA Surface, Rem	Square Yard
HMA Patch, Rem	Square Yard
Joint and Crack, Cleanout	Foot
Hand Patching	Ton
Pavt, Cleaning	Lump Sum
Pavt Joint and Crack Repr, Det __	Foot

A. **HMA, (type), High Stress**. The Department may pay for HMA, (type), High Stress for up to 150 feet outside the limits shown on the plans to allow time to transition to the high-stress HMA. The Department will pay for high-stress HMA placed outside the 150-foot limit as other HMA mix pay items.

B. **Pavement for Butt Joints, Removal.** The unit price for **Pavt for Butt Joints, Rem** includes the cost of removing and disposing of concrete or HMA materials.

C. **Edge Trimming.** The Engineer will measure **Edge Trimming** along the cut edge. The unit price for **Edge Trimming** includes the cost of cutting, removing, and disposing of excess HMA material.

D. **Cold Milling HMA Surface.** The unit price for **Cold Milling HMA Surface** includes the cost of removing, loading, hauling, weighing, and disposing of the cold-milled material, and cleaning the cold-milled pavement. If paid by the ton for cold-milled HMA, deposit the cold-milled material directly from the cold milling machine into the hauling units and weigh on a scale meeting the requirements of subsection 109.01.B before placement in a stockpile or a disposal area.

Material picked up by cleaning after cold milling is not weighed or paid for.

Macrotexture testing, macrotexture corrective actions, cleaning, and all other work related to mean texture depth requirements will not be measured and paid for separately but must be included in the work.

Separate payment will not be made for providing and maintaining an effective *Cold-Milling QC Plan*, nor for providing and maintaining an effective *Cold-Milling Operations Plan*.

E. **Pavement, Cleaning.** The Engineer will measure **Pavt, Cleaning** as a unit, including paved shoulders, approaches, and widened areas. The unit price for **Pavt, Cleaning** includes the cost of cleaning the foundation, joints, and cracks, and sweeping shoulders, base courses, and leveling courses.

If the Engineer directs additional hand or mechanical methods to clean the pavement, the Department will pay for this work as **Joint and Crack, Cleanout** if the contract includes the pay item. If the contract does not include a pay item for joint and crack cleanout, the Department will pay for additional hand or mechanical work as extra work, in accordance with subsection 109.05.

F. **Joint and Crack, Cleanout.** The Engineer will measure **Joint and Crack, Cleanout** along the cleaned joint and crack.

G. **Hand Patching.** The unit price for **Hand Patching** includes the cost of placing HMA, by hand or other methods, and compacting the material.

H. **Removing HMA Surface.** The Engineer will measure, and the Department will pay for removing HMA surface, no greater than 12 inches thick, overlying a material designated for removal or that is required to remain in place, as **HMA Surface, Rem**. The unit price for **HMA Surface, Rem** includes the cost of edge cutting to establish a neat line, as required, and removal and disposal of the HMA material.

For removal of HMA surfaces from structures, the unit price for **HMA Surface, Rem** includes the cost of removing old membrane.

The Engineer will measure, and the Department will pay for removing HMA surface, greater than 12 inches thick, overlying a material designated for removal or that is required to remain in place, as **Pavt, Rem** in accordance with subsection 204.04.

I. **Pavement Joint and Crack Repair.** The Engineer will measure **Pavt Joint and Crack Repr**, of the detail required, along the joint and crack. If the pavement joint and crack repair exceeds 30 inches in width, the Engineer will measure each 30-inch wide segment, or portion thereof, separately for payment. The Department will pay for the HMA material used to fill the joints after removal of objectionable material, as **Hand Patching**.

J. **Safety Edge.** Separate payment will not be made for constructing a safety edge. All costs associated with providing a safety edge, including base preparation and additional equipment or modification to existing equipment, will be included in the applicable unit prices for the related HMA mixtures.

K. **HMA.** The Engineer will measure, and the Department will pay for, **HMA** and **HMA, Temp Pavt (mix type)** of the mix specified based on the weight placed, as supported by weigh tickets. The Engineer will adjust the unit price for HMA of the mix specified, in accordance with the contract.

Section 711. Bridge Railings

711.01. Description

This work consists of providing and constructing bridge railings as shown in the contract.

711.02. Materials

Provide materials in accordance with the following sections:

Provide Grade 4500HP concrete for high-performance railings.

Provide Grade 4500 concrete for all other railing concrete.

Provide natural aggregate with a maximum absorption of 2.50% in accordance with ASTM C127. Do not use slag aggregate.

711.03. Construction

Do not slip form concrete railings.

A. **Structural Steel and Pipe Railings.** Shop drawings for structural steel and pipe railings are not required. Construct railing in accordance with section 707. Adjust metal railing before bolting connections to ensure that abutting joints match and align throughout the railing length.

Fabricate and weld in accordance with section 707. Perform NDT of welds in accordance with subsection 707.03.D.12.

Blast clean welded post assemblies before galvanizing. Shop clean and coat hot-dip galvanized structural steel railing in accordance with section 716 if shown in the contract.

After galvanizing, do not punch, drill, cut, or weld steel railing components. Only weld end caps and longitudinal seams made by the manufacturer. If the plans do not show or imply dimensional tolerances,

apply tolerances consistent with manufacturing practices and part function, including appearance.

Roll and bend tube rail sections with a hydraulic ram. Use a mandrel inside the tube rail with the hydraulic ram if the radius is less than 3 feet. Do not miter and cut, weld, or heat curve. Do not kink tubes in the radius section. Drop weight tear testing in accordance with ASTM E436 on curved tube sections is not required.

Bend rail sections before galvanizing. Provide at least 24 inches between compound curves. Provide tubes for curved sections with a wall thickness of at least ⅜ inch. Mill splice pieces to fit. Saw or mill the ends of tube sections. Cut ends true, smooth, and free of burrs or ragged edges. Cap open ends of the rail. Erect tube railing sections with the longitudinal seam weld facing downward.

Provide a continuous railing system, splicing each joint as shown on the plans. Splice rail tube sections in the same panel.

Before casting concrete, set anchor studs for railing posts using a template in accordance with subsection 706.03.L and as shown on the plans for spacing railing posts. Tighten nuts for the anchor studs and fasteners to a snug, tight condition in accordance with subsection 707.03.E.6.c.

B. **Concrete Railings**

1. **Parapet Railings.** Cast parapet railings in accordance with section 706. Provide smooth and tight-fitting forms. Rigidly hold forms to the line and grade shown on the plans and remove without damaging the concrete. Construct moldings, panel work, and bevel strips with mitered joints. Provide true, sharp, clean-cut, finished corners, free of cracks, spalls, and other defects. Provide a rubbed surface finish to exposed vertical and top surfaces in accordance with subsection 706.03.R.2.

2. **Bridge Barrier Railings.** Construct bridge barrier railings in accordance with section 706 and section 804.

3. **Bridge Barrier Railing Replacement**. Construct replacement barrier railings to the limits shown on the plans in accordance with subsection 711.03.B.2. Adhesive anchor barrier railing reinforcement into existing concrete in accordance with section 712.

C. **Timber and Lumber Railings.** Construct timber and lumber railing portions in accordance with section 709.

D. **Removal of Aluminum Railing.** Remove aluminum tube and posts on parapet railings. Leave anchor bolts in place.

E. **Bridge Railing, Thrie Beam Retrofit.** Drill holes or slots in thrie beam elements. Do not flame cut beam elements.

Core drill holes in existing concrete. Determine the location of existing reinforcement with a pachometer, or other nondestructive method, to avoid cutting existing reinforcement while coring. Avoid spalling concrete during drilling. If spalling occurs, remove loose concrete before installing bolts. Remove concrete fragments from the work area. Do not patch spalled areas.

Install nuts on bolts and studs at 5-inch slots in thrie beam expansion sections and finger-tighten. Fully engage nuts and bolts with at least one bolt thread extending beyond nuts. Upset the first thread outside the nut with a center punch or a cold chisel to prevent loosening. Tighten lag screws in 5-inch slots so washers fully contact beam elements, but do not impede movement due to expansion.

If thrie beam elements cover existing structure name plates, install new name plates near the end of railings on the fascia side. Attach name plates as shown on the plans, except make attachments with ⅜-inch-diameter expansion anchored bolts.

F. **Permanent Barrier Reflective Marker.** Use barrier markers the same color as reflector marking colors required for the location. Install markers using the manufacturer's recommended adhesive and in accordance with the manufacturer's recommendations.

Remove dirt or curing compound from bridge barrier railings or concrete barriers before installing barrier markers. Install barrier markers every 50 feet, placing the first marker within 50 feet of the end of the bridge barrier railing or concrete barrier. For bridge barrier railings or concrete barriers less than 50 feet long, place a second marker within 3 feet of the opposite end. Install the markers with the top of the marker 28 inches above the roadway surface.

G. **Bridge Railing, Aesthetic.** Construct aesthetic parapet or barrier railings in accordance with 711.03.B. Adjust the width of the parapet or barrier according to the details shown on the plans to accommodate form liners to accomplish texturing on the back of the bridge barrier railings and parapet railings.

Attach the guardrail to the bridge barrier railing with longer anchor bolts if required to accommodate the additional barrier thickness. Eliminate aesthetic texturing in guardrail anchorage area or provide a galvanized 14- by 26- by ⅜-inch plate if aesthetic textured concrete falls within guardrail anchorage limits.

711.04. Measurement and Payment

Pay Item	Pay Unit
Bridge Railing, Aesthetic Parapet Tube	Foot
Bridge Railing, Aesthetic Parapet Tube, High Performance	Foot
Bridge Railing, Aesthetic Parapet Tube, Det __	Foot
Bridge Railing, Aesthetic Parapet Tube, Det __, High Performance	Foot
Bridge Railing, Thrie Beam Retrofit	Foot
Bridge Railing, __ Tube	Foot
Bridge Barrier Railing, Type __	Foot
Bridge Barrier Railing, Type __, High Performance	Foot
Bridge Barrier Railing, Type __, Replacement	Foot
Bridge Barrier Railing, Type __, Replacement, High Performance	Foot
Bridge Barrier Railing, Aesthetic, Type __, Det __	Foot
Bridge Barrier Railing, Aesthetic, Type __, Det __, High Performance	Foot
Bridge Barrier Railing, Aesthetic, Type __, Det __, Replacement	Foot
Bridge Barrier Railing, Aesthetic, Type __, Det __, Replacement, High Performance	Foot
Pipe Railing, (material)	Foot
Reflective Marker, Permanent Barrier	Each

A. **General.** The Engineer will measure, and the Department will pay for, reinforcing steel and aesthetic texturing as specified in subsection 706.04. The Engineer will measure, and the Department will pay for, adhesive anchoring of steel reinforcement as specified in subsection 712.04. The Engineer will measure, and the Department will pay for, furnishing light standard anchor bolt assemblies as specified in subsection 819.04. The **High Performance** pay items denote railings that are high performance.

B. **Bridge Railing, Aesthetic Parapet Tube.** The Engineer will measure the **Bridge Railing, Aesthetic Parapet Tube** pay items based on plan quantities. The unit price for the **Bridge Railing, Aesthetic Parapet Tube** pay items includes the cost of the following:

1. Providing and placing concrete parapets and end walls;
2. Providing and placing tube railing;
3. Constructing joints;
4. Providing and placing anchor bolts or insert sleeves;
5. Forming, finishing, curing, and protecting the concrete; and

6. Placing light standard anchor bolt assemblies.

Bridge Railing, Aesthetic Parapet Tube of the detail specified includes the cost of the concrete that fills form liners and the concrete necessary to construct the railing to the shape shown on the plans.

C. **Bridge Railing, Thrie Beam Retrofit.** The Engineer will measure **Bridge Railing, Thrie Beam Retrofit** based on plan quantities. The unit price for **Bridge Railing, Thrie Beam Retrofit** includes the cost of attaching guardrail anchorages to bridge railing end posts and providing and installing new structure name plates. The Department will pay for reflectorized washers separately.

D. **Bridge Railing Tubes.** The Engineer will measure **Bridge Railing, __ Tube** based on plan quantities. The unit price for **Bridge Railing, __ Tube** includes the cost of the following:

1. Providing and placing tube railing;
2. Providing and placing anchor bolts or insert sleeves; and
3. Placing light standard anchor bolt assemblies.

The Department will pay for concrete end walls and concrete brush blocks separately as specified in subsection 706.04.

E. **Bridge Barrier Railing.** The Engineer will measure the **Bridge Barrier Railing** pay items of the specified type based on plan quantities. The unit price for the **Bridge Barrier Railing** pay items of the specified type includes the cost of the following:

1. Providing and placing concrete;
2. Constructing joints;
3. Forming, finishing, curing and protecting the concrete; and
4. Placing light standard anchor bolt assemblies.

The **Aesthetic** pay items include the cost of the concrete that fills form liners and concrete necessary to construct the railing to the shape shown on the plans. The **Replacement** pay items include adjustments in construction operations necessary to construct railings on existing concrete.

F. **Pipe Railing.** The Engineer will measure the length of **Bridge Railing, Pipe** based on plan quantities.

G. **Reflective Marker, Permanent Barrier.** The unit price for **Reflective Marker, Permanent Barrier** includes the cost of providing and installing the marker.

Section 802. Concrete Curb, Gutter, and Dividers

802.01. Description

This work consists of constructing the following items on the prepared base, with or without reinforcement, as required by the contract:

A. Concrete curb, combination curb and gutter, and curb nose;

B. Valley gutter and shoulder gutter;

C. Downspout headers and spillways; and

D. Dividers.

802.02. Materials

Provide materials in accordance with the following sections:

802.03. Construction

A. **Preparation of Base.** Prepare the base in accordance with subsection 602.03.B. Construct a uniform base. Compact the base material to 95% of the maximum unit weight. Prepare the base and geotextile liner for concrete spillways in accordance with subsection 814.03.A.

B. **Placing Forms.** Place fixed forms in accordance with subsection 602.03.C. Use face forms, if necessary, to construct straight curbs.

If using slip-forming methods, match the dimensions of the form to the dimensions of the curb shown on the plans.

C. **Placing Steel Reinforcement.** Place steel reinforcement and lane ties in the correct position during concrete placement, as required.

Splice steel reinforcement bars by lapping them at least 10 inches. Tie bar laps with wire ties within 2 inches of each end of the lap.

D. **Placing Concrete.** Obtain the Engineer's approval of the base before placing concrete. Wet the base before placing concrete.

For concrete curbing constructed as an integral part of the concrete pavements, except at night headers, place concrete curbing within

30 minutes of placing the concrete for the pavement. At night headers, use ties and methods approved by the Engineer.

Construct transitions between concrete valley gutter and concrete curb and gutter in accordance with section 602.

Place concrete to the required depth and spade or vibrate to ensure consolidation.

Apply membrane-curing compound as soon as concrete has been placed and in areas requiring repairs after the repairs have been made.

Repair honeycombed areas or voids with Type R-2 mortar.

E. **Joints.** Construct joints perpendicular to the surfaces of the curb, gutter, or dividers in accordance with the *MDOT Standard Plan R-30* or *R-33* series. Seal joints in accordance with subsection 602.03.S.

1. **Contraction Joints and Plane-of-Weakness Joints.** Construct joints, in accordance with plans, to ensure a plane-of-weakness at least one-fourth the depth of the section.

2. **Expansion Joints.** Place expansion joint filler to the full depth of the joint. Recess the top of the joint filler ¼ to ½ inch below the finished surface of the structure.

F. **Finishing.** Round the exposed edges to a ¼-inch radius, including transverse joints. Shape the face of the curb to produce the radii shown on the plans. Fill low spots with the same concrete mixture used in the work.

Finish exposed surfaces smooth and even, and lightly brush using a broom or brush. Finish the gutter and top of curb to within 3⁄16 inch of the plan dimensions when checked with a 10-foot straightedge. Finish other exposed surfaces to within ⅜ inch of the plan dimensions.

Do not add water to the concrete surface to aid finishing.

G. **Stenciling.** Stencil survey station numbers, in accordance with subsection 602.03.L, into the exposed surface of continuous runs of concrete curb, gutter, curb and gutter, and driveway opening, or shoulder that directly adjoins the traveled way. Stenciling curb and gutter is not required if concrete barrier is present and is stenciled in accordance with subsection 602.03.L.

Place stencil numbers as follows:

1. To be read from the traveled way;

2. On one side of one-way roadways (preferably the right side);

3. On both sides of the traveled way of two-way roadways; and
4. Midway up on the face of a curb or 2 inches from the back of a gutter or driveway opening.

Do not stamp, stencil, or in any way mark concrete with a company name, logo, or other such information.

H. **Curing.** Cure concrete curb, gutter, and dividers in accordance with subsection 602.03.M.

I. **Weather and Temperature Limitations.** Protect concrete curb, gutter, and dividers in accordance with subsection 602.03.T.

J. **Backfilling.** Place and compact backfill after the concrete gains the needed strength to support placing and compacting. Grade the remaining excavated areas.

802.04. Measurement and Payment

Pay Item	Pay Unit
Curb, Conc, Det __	Foot
Curb and Gutter, Conc, Det __	Foot
Valley Gutter, Conc	Foot
Curb and Gutter, Bridge Approach, Det__	Foot
Shld Gutter, Conc, Det __	Each
Curb Nose	Each
Downspout Header, Conc	Each
Driveway Opening, Conc, Det M	Foot
Spillway, Conc	Foot
Divider, Conc, Type __	Square Foot

A. **Concrete Acceptance.** Conduct concrete QC as specified in section 1002. The Engineer will conduct QA as specified in section 1003. The Department will apply adjustments to this work based on the QA results.

B. **Curb, Concrete; Curb and Gutter, Concrete; Valley Gutter, Concrete; and Curb and Gutter, Bridge Approach, Det__.** The Engineer will measure **Curb and Gutter, Conc, Det __**, **Valley Gutter, Conc**, and **Curb and Gutter, Bridge Approach, Det__** in place along the joint of the curbing with the pavement. The Engineer will not make deductions in the pay item measured length for catch basins, inlet castings, or Detail L driveway openings. The Engineer will divide transition areas between **Valley Gutter, Conc** and **Curb and Gutter, Conc** in half and will measure each half in the units of the adjacent item.

C. **Integral Curb and Pavement Construction.** If the Contractor chooses to construct curb as an integral part of the pavement, the Engineer will

measure the curb separately. The Department will not consider payment for extras or increases in pay quantities due to the Contractor's choice to cast curbing integral with the pavement.

D. **Shoulder Gutter, Concrete.** The unit price for **Shld Gutter, Conc, Det __** includes the cost of providing and placing a geotextile liner. The plans will show the pay limits for **Shld Gutter, Conc, Det __.**

E. **Driveway Opening, Conc, Det M**. The Engineer will measure **Driveway Opening, Conc, Det M** from springline to springline.

F. **Spillway, Concrete.** The unit price for **Spillway, Conc** includes the cost of providing and placing a geotextile liner.

G. **Divider, Concrete, Type __.** The unit prices for concrete divider include the cost of steel reinforcement, if required.

H. **Excavation and Backfill.** Unless the contract includes separate pay items for excavation and backfill, the unit price for other items of work will include the cost of excavation and backfilling.

Section 807. Guardrail, Guardrail Terminals, and Miscellaneous Posts

807.01. Description

This work consists of constructing, reconstructing, and erecting guardrail, guard posts, guide posts, guardrail terminals, guardrail anchorages, and mailbox posts; and excavating, backfilling, and disposing of surplus materials.

807.02. Materials

Provide material in accordance the following sections:

807.03. Construction

A. **Grading and Drainage.** Before constructing guardrail elements, grade the shoulder and berm to provide drainage. For approach guardrail terminals, grade to Class A slope tolerances.

Remove excess material and dispose in accordance with subsection 205.03.P. The Engineer may allow this material to be spread thinly over the roadway slopes, provided it does not kill vegetation or block drainage.

B. **Placing Posts.** Drive posts or set posts in augered holes. For posts located within 3 feet of existing culverts, set posts in drilled holes. The bottom of the holes must be within 3 inches of the dimension shown on the plans. Compact the bottom of drilled holes to provide a stable foundation. Verify that the exposed portion of posts meets plan dimensions. Backfill the posts with sound earth compacted in 12-inch layers. The posts must be plumb after installation is complete.

Remove and replace posts damaged during driving that would prevent proper functioning of the guardrail, as determined by the Engineer. Do not damage nearby structures, shoulders, or slopes during driving. Replace damaged posts and repair damage to structures, shoulders, and slopes at no additional cost to the Department.

Use the same material for all posts in a discrete run of guardrail, except where the plans require wood posts. Do not burn or weld posts in the field.

C. **Guardrail Beam Elements, Blocks and Hardware.** Erect beam guardrail to conform to the line and grade shown in the contract.

Bolt the beam elements and blocks to each post. Make splices only at posts by lapping in the direction of traffic. Do not burn or weld beam elements in the field. Where placing guardrail on a curve with a radius between 150 and 1,000 feet, tighten splice bolts before attaching to the posts.

Shop bend beam elements for curves with a radius of 150 feet or less. Identify each shop-bent curved beam element with a metal tag or permanent marking showing the radius of curvature to the nearest 5 feet as shown on the *MDOT Standard Plan R-60* series.

Bolt lengths shown on the plans are based on the standard dimensions given for the materials and do not include manufacturer's tolerances. Draw bolts tight and flush with the nuts. If using wood posts, do not leave bolts for Type BD, Type TD, and Type MGS-8D guardrail extending more than ½ inch beyond the nuts. Do not leave bolts for other types of guardrail extending more than 1½ inch beyond the nuts.

D. **Repair of Wood Posts and Blocks.** Field treat cuts, holes, and damage to posts and blocks that occur after pressure treatment, in accordance with subsection 912.03.

E. **Repair of Damaged Galvanized Surface.** Repair zinc coating on beam elements, steel posts, and fittings damaged in transporting, handling, or erection. Apply zinc coating to bare metal surfaces after drilling holes or slots on beam elements. Make repairs to galvanized surfaces in accordance with subsection 716.03.E and at no additional cost to the Department.

F. **Guardrail Terminals and Anchorages.** For guardrail terminals, the Engineer will allow field drilling of galvanized beam elements to attach terminal end shoes and anchor plates. Install the reflectorized obstacle marker panel on the nose of each terminal in accordance with the manufacturer’s specifications.

For structure anchorages, either sleeve or core drill bolt holes through concrete. Avoid spalling concrete during coring. If spalling occurs, remove the fragments and loosened concrete before installing the bolt.

Install curved guardrail anchorages when specified on the plans or when specified by the Engineer. Place the guardrail on a curve as shown on the plans or directed by the Engineer.

G. **Adjusting or Reconstructing Guardrail.** Disassemble, sort, and stockpile the existing guardrail beam elements and endings. Sort the

stockpiles of different elements into reusable and unusable material. Obtain the Engineer's approval for reuse prior to installation. Remove concrete anchor blocks at the end of turned-down guardrail anchorages and concrete footings for old guardrail cable anchorages. Unless otherwise indicated on the plans, any unusable material will become the property of the Contractor.

Drill new slots in the beam elements and anchorages when needed in accordance with the *MDOT Standard Plans*.

Re-erect the reusable beams or new beams, offset/spacer, or wood block outs on new or existing posts in accordance with the *MDOT Standard Plans.*

Backfill and compact the old post holes and voids caused by removal of concrete anchor blocks and footings in layers no greater than 12 inches.

Adjust guardrail heights as shown on the *MDOT Standard Plan R-60* series. Make height adjustments in the block mounting location only. Do not lift existing posts to adjust rail height. Ensure that the post bolt (for Guardrail, Type B and Guardrail, Type MGS-8) or upper post bolt (for Guardrail, Type T) is not closer than 2 inches from the top of the wood or steel post. Field drill new holes in the existing post if necessary.

Make height adjustments to usable, existing guardrail approach terminals by reconstruction (complete removal and reinstallation) only. Replace unusable and substandard terminals with new standard terminals.

H. **Incomplete Guardrail Installations.** Within 5 calendar days, complete a continuous section of guardrail, including structure anchorages and guardrail terminals, or bridge thrie beam retrofit guardrail. This time period begins with the start of work on a continuous section of guardrail, and ends with the completion of work on a continuous section of guardrail.

Deliver adequate materials on the project before removing sections of guardrail or beginning new installations. Leave existing guardrail in place until preparatory work such as widening, embankment, and other construction items are complete. To reduce exposure of unprotected areas, coordinate and expedite shoulder construction where guardrail removal and replacement will occur.

If a guardrail section cannot be completely removed or installed by the end of the working day and the exposed beam element ending would face oncoming traffic, temporarily attach a terminal end shoe in accordance with the *MDOT Standard Plan R-66* series. A terminal end shoe of appropriate type based on the beam guardrail installed must be used on all guardrail installations. A cable assembly and strut are not required.

Attaching the terminal end shoe does not waive the 5-day completion requirement.

If the bridge approach guardrail cannot be properly attached to the bridge railing or connected to the bridge thrie-beam retrofit guardrail, fit the free end of the rail with the required special end shoe or thrie-beam terminal connector and temporarily attach to the bridge rail in accordance with the following:

1. Fit the exposed thrie-beam retrofit beam ending that faces oncoming traffic with a thrie-beam terminal connector. Attach the terminal connector to the reinforced concrete railing. Install and tighten splice bolts. Secure the terminal connector to the railing with at least one bolt extending completely through the railing in accordance with the *MDOT Standard Plan R-67* series.
2. Attach bridge approach guardrail that cannot be properly attached to the bridge railing, to a portion of reinforced concrete railing in accordance with the *MDOT Standard Plan R-67* series, except that only one bolt will be required to secure the special end shoe or thrie-beam terminal connector to the railing. Install and tighten splice bolts. Extend the rail at least 3½ feet onto the bridge. If the Engineer approves, this temporary attachment may remain beyond the 5-day requirement stipulated above.
3. If the area of incomplete or removed guardrail is not behind traffic control devices installed for other work, install a lighted SHOULDER WORK (W21-5) sign and lighted, steady-burn, plastic drums, spaced at maximum intervals of 100 feet to delineate the incomplete portion of the guardrail section during the time it is exposed to traffic. Place plastic drums near the edge of the shoulder. Other traffic control devices may be required by the contract, or as directed by the Engineer.

I. **Temporary Beam Guardrail and Temporary Guardrail Terminals.** Construct temporary beam guardrail and temporary guardrail terminals in accordance with subsection 807.03 for beam guardrail and guardrail terminals. The Engineer may approve the use of salvaged or new materials for temporary installations; ensure that the Engineer approves before using salvaged materials.

Remove the guardrail and terminals when no longer required. Backfill and compact the post holes in lifts no greater than 12 inches. Take possession of the materials, disassemble, and remove them from the project.

J. **Salvaging Beam Guardrail.** Remove existing single or multiple beam guardrail and posts. Backfill the post holes in layers compacted to no

greater than 12 inches. Deliver the beam elements to the locations designated in the contract, and stack the beams neatly, according to length. Unless otherwise required by the contract, take ownership of posts and hardware.

K. **Mailbox Posts.** Move existing mailbox supports and mailboxes, but maintain serviceability during construction. Install a new post at the permanent location after construction is complete. Attach the existing mailbox to the post and dispose of the existing support at the property owner's option. Set mailbox posts in the ground so the top is 4 feet above the surface of the shoulder of the road or mailbox turnout. The Engineer will determine the exact height. Use posts in accordance with the *MDOT Standard Plan R-74* series and saw the top of the post level. The Engineer may approve alternate mailbox support designs that meet the criteria specified in the requirements of the AASHTO *Manual for Assessing Safety Hardware* (MASH). Remove, store, and provide to the property owner, newspaper boxes and supports that interfere with construction.

L. **Guard Posts and Guide Posts.** Drive or set guard and guide posts in drilled holes in accordance with subsection 807.03.B.

807.04. Measurement and Payment

Pay Item	Pay Unit
Guardrail, Curved, Type __	Foot
Guardrail, Type __	Foot
Guardrail Post, Culv	Each
Guardrail Approach Terminal, Type __	Each
Guardrail Departing Terminal, Type __	Each
Guardrail Anch, Bridge, Det __	Each
Guardrail Anch, Median	Each
Guardrail Reflector	Each
Guardrail, Type __, Temp	Foot
Guardrail Approach Terminal, Type __, Temp	Each
Guardrail Departing Terminal, Type __, Temp	Each
Guardrail Anch, Bridge, Det __, Temp	Each
Guardrail, Salv	Foot
Guardrail, Mult, Salv	Foot
Post, Mailbox	Each
Post, Wood Guard	Each
Post, Wood Guide	Each
Guardrail, Reconst, Type __	Foot
Guardrail Post, Furn and Install, __ inch	Each
Guardrail Height, Adj	Foot

Guardrail Anchored in Backslope, Type __..... Each
Guardrail Anch Bridge, Det __, Curved..... Each

A. **Blading.** The cost of grading the shoulder and berm to provide drainage and disposing of excess material is included in unit price for related items of work.

B. **Guardrail.** The Engineer will measure **Guardrail, Curved, Guardrail** and **Guardrail, Temp** along the face of the rail, excluding terminals and end shoes. The unit price for **Guardrail, Curved** includes the cost of portions of guardrail with shop-bent beam elements.

The unit price for **Guardrail** includes the cost of providing and placing guardrail posts, blocks, and miscellaneous hardware.

The unit prices for **Guardrail, Temp, Guardrail Approach Terminal, Temp**, and **Guardrail Departing Terminal, Temp** include the cost of removing temporary guardrail and terminals and backfilling postholes. The cost of providing, installing, and removing temporary guardrail beam elements, terminal end shoes, transition elements and hardware, and traffic control items described for incomplete guardrail installations in subsection 807.03.H.3 is included in the unit price for related guardrail pay items.

The Engineer will measure **Guardrail, Salv** and **Guardrail, Mult, Salv** along the face of the rail (one face for multiple beams), including terminals and end shoes.

Guardrail Reconstruction includes guardrail constructed using new or existing posts and reused beam elements of the type specified, measured by length in feet along the face of the rail, including reused existing terminals. The work includes:

1. Removing existing guardrail, guardrail approach terminals, guardrail departing terminals, thrie-beam retrofits, and guardrail anchorages;
2. Furnishing, as necessary, new posts, offset blocks, spacer blocks, wood blockouts, bolts, reflectors, and other pertinent fittings;
3. Backfilling old postholes;
4. Field drilling beam elements and repairing damaged galvanized surfaces;
5. Drilling holes in bridge railings, concrete barriers, and other concrete structures;
6. Transporting beam elements within the project limits; and

7. Dismantling, separating, and stockpiling elements and disposing of waste or scrap material.

Reconstructed guardrail anchorages will be paid for as **Guardrail, Reconst, Type __** when rebuilt with existing beam elements. Otherwise, guardrail anchorages constructed with all new components will be paid for as **Guardrail Anch, Bridge, Det __** or **Guardrail Anch, Median**.

Reconstructed thrie-beam retrofit will be measured and paid for as **Guardrail, Reconst, Type __** when rebuilt with existing beam elements. **Bridge Railing, Thrie Beam Retrofit** will be paid for separately if it is necessary for the Contractor to furnish new thrie-beam retrofit installations due to insufficient quantities of reusable elements available on the project.

Reconstructed long-span guardrail will be measured and paid for as **Guardrail, Reconst, Type __** when rebuilt with existing beam elements. New long-span guardrail, of specified detail type, will be paid for separately with other pay item(s), as specified in the contract or as specified by the Engineer, if it is necessary for the Contractor to furnish new long-span guardrail installations due to insufficient quantities of reusable elements available on the project.

Reconstruction of reusable existing guardrail approach and departing terminals that meet current standards and if approved by the Engineer will be measured and paid for as **Guardrail, Reconst, Type __.**

Payment for removal of existing buried ends is included in the item of **Guardrail, Reconst, Type __**. Where only the existing terminal or anchorage is removed in a run that is otherwise not reconstructed, the removal will be paid for as **Guardrail, Rem**.

Installing posts within existing guardrail post intervals to modify the guardrail will be measured as units of **Guardrail Post, Furn and Install, __ inch** of the post length specified. The pay item includes furnishing and installing posts, offset blocks, bolts, and necessary fittings.

Guardrail Height, Adj will be measured in feet along the face of the rail adjusted and includes all necessary field drilling of existing posts. Pay quantities will be in increments of the post spacing called for on the plans, excluding anchorages and end shoes.

Guardrail Approach Terminal, Type __ of the type specified will be paid for separately when required to replace unusable or substandard existing approach terminals. **Guardrail Departing Terminal, Type __** of the type specified will be paid for separately when required to replace unusable or substandard existing departing terminals.

Guardrail, Type __ and **Guardrail, Curved, Type __** of the type specified will be paid for separately if it is necessary for the Contractor to furnish new beam elements due to insufficient quantities of reusable elements available on the project.

Guardrail Anchored in Backslope, Type __ includes all materials, equipment, labor, including slope excavation, and backfill. When a W-beam rubrail is called for on the plans, the unit price for **Guardrail Anchored in Backslope, Type __** includes all materials, labor, and equipment for installation of the W-beam rubrail.

Guardrail Anch Bridge, Det__, Curved includes all materials, labor, and equipment to construct a curved guardrail bridge anchorage of specified detail, with the curve radius shown on the plans or as directed by the Engineer.

C. **Guardrail Terminals.** Each terminal will be considered an individual unit.

The unit price for **Guardrail Approach Terminal** includes the cost of proprietary and standard elements, hardware required for installation, including obstacle marker panel, and terminal end shoes.

The unit price for **Guardrail Departing Terminal** includes all materials, labor, and equipment to construct a departing terminal, excluding curved beam elements requiring shop bending. Curved beam elements requiring shop bending will be paid for separately as **Guardrail, Curved, Type__.**

D. **Miscellaneous Posts.** The unit price for **Post, Mailbox** includes the cost of the following:

1. Removing and relocating the existing mailbox support during construction activities;
2. Maintaining serviceability;
3. Placing a new post at the permanent location after construction activities are complete;
4. Removing the mailbox from the old support and attaching it firmly to the new post;
5. Disposing of the old support at the property owner’s option; and
6. Removing, storing, and providing the existing newspaper boxes and supports to the property owner.

The unit price for **Guardrail Post, Culv** includes all labor, materials, and equipment necessary to complete the installation in accordance with the *MDOT Standard Plan R-73* series.

Section 808. Fencing

808.01. Description

This work consists of providing and erecting, or moving existing, woven wire fence, temporary fence, protective fence, chain link fence, high-tensile wire fence, or pedestrian fencing of structures.

808.02. Materials

Provide materials in accordance with the following sections:

A. **Protective Fencing.** Provide new or used material for temporary and protective fencing. Wood posts for protective fencing do not require preservative treatment.

B. **Fence Fabric.** Provide either zinc-coated steel or aluminum-coated steel fabric for chain link fence. Only use polyvinyl chloride (PVC) coated fence fabric if required by the contract.

C. **Moving and Salvaging Fence.** The Engineer may approve material salvaged from moved, temporary, or protective fencing for use as permanent fence provided it meets the requirements of section 907. Provide additional materials in accordance with section 907.

D. **Polyvinyl Chloride.** Meet the requirements in subsection 907.04 with the exception that the chain link fence and gates must be 48-inch thermal fused with a black, plasticized PVC coating.

1. **Fabric.** The vinyl-coated steel chain link fence must meet the requirements of ASTM F668 Class 2b. The core must be 0.148 inch in diameter. The mesh size must be 2 inches. The PVC coating must be black in accordance with ASTM F934.

2. **Framing.** The framing must be hot-dipped galvanized prior to vinyl coating. The thickness of the vinyl coating must be 10 to 14 mils applied by fusion bonding.

Provide a general certification that the materials provided meet the requirements stated above. The Department will conduct acceptance testing in accordance with subsection 907.02.

808.03. Construction

Erect a taut fence to the line required by the contract. Dispose of surplus excavated material and other debris in accordance with subsection 205.03.P. The Engineer will designate and mark trees and other vegetation to be saved. Construct the fence near designated vegetation and in naturally occurring wet areas, by hand, as directed by the Engineer.

A. **Concrete.** Place concrete per section 1004.

B. **Woven Wire Fence.** Use wood posts in swamps and areas of unstable soil.

If necessary to confine livestock, erect the permanent fence before removing the existing fence. If the permanent fence must be installed in the same location as the existing fence, install temporary fencing to be paid for as Fence, Temp at the contract unit price.

Install fencing near schools, play areas, or residential yards prior to removing the existing fencing.

1. **Clearing Fence Line.** Where clearing for fence is required, clear the fence line in accordance with subsection 201.03.C.

2. **Setting Posts.** Dig holes for wood posts in accordance with the *MDOT Standard Plan R-101* series with a tolerance of 3 inches.

   Leave at least 4½ feet of the post exposed. Set the wood posts plumb on the side designated for fastening the wire. Set with the butt end down. Backfill around the post with sound earth, thoroughly compacted in place.

   Steel posts must be plumb. Remove and replace bent or damaged posts.

   When placing posts, maintain the tops of posts at a uniform height above the ground. After erecting the fence, cut off the tops of wood posts to the required elevation.

   Set an intersection post in line with intersecting fences and brace in line with the intersecting fence. Connect both intersecting fences to the intersection post.

3. **Anchoring and Bracing Wood Posts.** Anchor and brace wood posts, except intermediate line posts, in accordance with the *MDOT Standard Plan R-101* series.

   If using cleats to anchor wood posts, use sawed lumber with durability equal to that of the posts. Secure timber braces to the post using galvanized spikes.

Install a cable composed of double strand, No. 9 galvanized wire, in accordance with the *MDOT Standard Plan R-101* series. Loop the cable around the end, corner, gate, angle, intersection, or intermediate braced post, and around the adjacent line post. Twist the cable until the top of the adjacent line post is drawn back 2 inches. Secure the cable to maintain tension.

4. **Anchoring and Bracing Steel Posts**. Anchor and brace steel posts in accordance with the *MDOT Standard Plan R-101* series.

   Brace end and gate posts with one brace in the direction of strain. Brace corner, angle, and intermediate posts in both directions. Brace intersection posts in three directions. Fasten braces near the top of the post. At depressions and alignment angles where stresses are created that may pull the posts from the ground, set the line posts in concrete.

5. **Installing Fabric and Barbed Wire**. Wrap each horizontal strand of wire around the end, corner, gate, or intermediate braced post and wind around the wire leading up to the post.

   Stretch the wire fabric taut and fasten it to each post with the bottom of the fabric 2 inches above the ground. Use line posts as stretching anchorage only if they are anchored in concrete.

   Obtain the Engineer's approval for the method of splicing wires in woven wire fabric and barbed wire. Make the distance between the vertical wire stays, next to the splice, equal to the unspliced sections of woven wire fabric. Splice a woven wire and barbed wire fence only if connecting two rolls of wire. Do not make intermediate splices.

   Fasten the fence fabric to each steel post with at least six wire clamps.

   Attach the fence to each wood post with at least one staple for each horizontal strand. Use staples made of 9-gauge galvanized steel wire, at least 1½ inch long for soft wood or at least 1 inch for hard wood posts.

   Fasten the barbed wire to each post 3 to 4 inches above the fabric.

6. **Installing Vinyl Coated Chain Link Fence**. Conduct the work according to section 808, the *MDOT Standard Plan R-98* series for the gates, and the *MDOT Special Detail 99* for the fence.

   Electronically submit one complete set of manufacturer's specifications to the Engineer for approval a minimum of 14 work days prior to fabrication of the materials. Do not fabricate any materials prior to receiving approval from the Engineer.

C. **Temporary Fence.** Erect temporary fence in accordance with subsection 808.03.A and subsection 808.03.B, except as modified by the following:

1. **Setting Posts.** Set line posts at least 2 feet into the ground and end posts at least 3 feet into the ground and do not trim the tops. The Engineer may allow the omission of intermediate braced posts.

2. **Installing Fabric.** Attach the fabric to wood posts with at least one staple for every third strand or to steel posts with at least four wire clamps.

3. **Removing Temporary Fence.** Remove and dispose of the temporary fence, or salvage in accordance with subsection 808.02.C.

D. **Protective Fence.** Place a protective fence around excavations for bridges and pump stations, and other areas of the project in accordance with subsection 104.07.B and the plans, or as directed by the Engineer. Erect protective fence in accordance with subsection 808.03.A and subsection 808.03.B, except as modified by the following:

1. **Anchoring and Bracing Posts.** Anchor and brace enough posts to keep the fabric taut.

2. **Maintaining Fence.** Maintain the protective fence until the Engineer directs its removal or accepts the project.

3. **Removing Protective Fence.** Remove and dispose of the protective fence.

E. **Chain Link Fence.** Erect chain link fence on steel posts set in concrete.

1. **Clearing Fence Line.** Clear the fence line in accordance with subsection 201.03.C.

2. **Setting Posts.** Set posts in concrete and brace. Install angle posts where the alignment of the fence deflects more than 10 degrees.

   Set an intersection post in line with intersecting fences. Connect both intersecting fences to the intersection post.

   Fit posts with Department-approved post caps.

3. **Braces.** Fasten braces to the end, corner, angle, intersection, gate, and intermediate braced posts with required steel fasteners.

4. **Installing Fabric and Top Tension Wire.** Stretch chain link fence fabric taut and fasten to each post with Department-approved fasteners. Space the fasteners no greater than 12 inches apart on the posts. Fasten the fence fabric to the tension wire, at no greater than 15-inch intervals, using fasteners fabricated from 12-gauge galvanized

wire. Close fasteners to the full crimp position around the tension wire and fence fabric.

F. **High-Tensile Wire Fence.** Construct high-tensile wire fence in accordance with subsections 808.03.A and 808.03.B. Erect the wires in accordance with the manufacturer's recommendations.

G. **Fencing on Structures.** Construct fencing on structures in accordance with subsection 808.03.E. Install a fully compressed lock washer on the bolt threads of exposed nuts. Construct handrails, as shown on the plans, as part of the fencing in accordance with section 707.

H. **Moving Fence.** Remove the existing fence without damaging the materials. Set posts and anchors in the same manner and to the same depth and spacing as the original fence. Place the reset fence in at least as good condition as the existing fence before it was moved. If the fence consists of wire fabric, draw it taut but do not overstress the salvaged materials. Replace damaged or destroyed materials at no additional cost to the Department.

808.04. Measurement and Payment

Pay Item	Pay Unit
Fence, Temp	Foot
Fence, Protective	Foot
Fence, Woven Wire with Wood Post	Foot
Fence, Woven Wire with Steel Post	Foot
Barbed Wire	Foot
Fence Gate, __ foot, for Woven Wire	Each
Fence, Chain Link, __ inch	Foot
Fence, Chain Link, __ inch, with (number) Strand of Barbed Wire	Foot
Fence Gate, __ foot, for __ inch Chain Link Fence	Each
Fence, High Tensile Wire	Foot
Fence, Structure	Square Foot
Fence, Moving	Foot
Fence Post	Each
Fence Material	Foot
Fence, Chain Link, __ inch, Vinyl Coated	Foot
Fence Gate, __ foot, for __ inch Chain Link Fence, Vinyl Coated	Each

A. **Concrete Acceptance.** Conduct concrete QC as specified in section 1002. The Engineer will conduct QA as specified in section 1003. The Department will pay for this work based on the QA results.

B. **Fence.** The Engineer will measure fence in place and will not include gate openings in the measurement for **Fence, Temp; Fence, Woven Wire;**

Fence, Moving; and **Fence, Chain Link**. The Engineer will measure gates separately.

The unit price for fence of the type required includes the cost of providing and installing posts, braces, fabric, and hardware.

The Department will not make adjustments in price for handwork required to avoid damage to trees and vegetation designated to be saved.

If required, the Engineer will measure, and the Department will pay for, barbed wire separately except that the unit price for **Fence, Chain Link, __ inch, with (number) Strand of Barbed Wire** includes barbed wire.

C. **Temporary and Protective Fence.** The Department will not pay separately for protective fence required in accordance with subsection 104.07.B.

If the Engineer directs, or the plans show, the use of protective fence, the unit price for **Fence, Protective** includes the cost of providing and placing.

The unit prices for **Fence, Temp** and **Fence, Protective** include the cost of providing, erecting, maintaining, removing, and disposing of fence.

The Engineer will not deduct openings from measurements for **Fence, Protective**. The Engineer will not measure gates separately.

D. **Fence, Structure.** The unit price for **Fence, Structure** includes the cost of providing and installing posts, braces, and fabric, and all supporting, connecting, and auxiliary elements, including handrails if shown on the plans, for the erection of fences on existing or new structures.

E. **Fence, Moving.** The Engineer will measure **Fence, Moving** in place at its new location. The unit price for **Fence, Moving** includes the cost of disassembling, moving the fence, and installing it in its new location. The unit price also includes replacing posts or fabric damaged or destroyed by the Contractor's removal operation.

The Department will pay for new posts or new fence material, if shown on the plans or required by the Engineer, at the contract unit price for these items. If the contract does not include new post or new fence material pay items, the Department will pay for these as extra work.

Section 810. Permanent Traffic Signs and Supports

810.01. Description

This work consists of providing, fabricating, and erecting traffic signs and supports in accordance with the *Michigan Manual on Uniform Traffic Control Devices* (MMUTCD), *Michigan Standard Highway Signs Manual*, and MDOT's *Sign Support Standard Plans*.

A. Definitions

Defect. Physical imperfections affecting function, performance, or durability of a sign or support. Defects include dents, scratches, nicks, blemishes, mottles, dark spots, scuffs, streaks, warpage, sheeting lift, and bolt head dimples.

Patch. Small piece of reflective sheeting material used to cover a defect or imperfection on a sign surface.

Post Spacing. Center-to-center distance between posts.

Substrate. Material to which sheeting is applied (wood or aluminum).

Warp. Deformation caused by bending or twisting in posts or substrate.

Wedge. Tapered hardwood used to secure wood posts in sleeves.

810.02. Materials

Provide materials in accordance with the following sections:

Provide Grade 3500 concrete for cantilever and truss sign support foundations. Provide Grade 3000 concrete for other sign support foundations.

810.03. Construction

Before beginning excavation or post-driving operations, determine the location of underground utilities as specified in section 107.

Place signs at the bottom height shown on the plans or in accordance with MDOT's *Sign Support Standard Plans*.

Repair zinc coating on sign supports damaged during transportation, handling, or erection in accordance with subsection 716.03.E and at no additional cost to the Department.

A. **Fabrication**

1. **Trusses and Cantilevers.** Fabricate in accordance with MDOT's *Sign Support Standard Plans* and as provided on the plans and as required in sections 707 and 716.
2. **Steel Column Breakaway Sign Supports.** Fabricate in accordance with MDOT's *Sign Support Standard Plans*. Blast clean and galvanize structure components in accordance with section 716. Field verify the correctness of breakaway heights.
3. **Bridge Sign Connections.** Fabricate in accordance with MDOT's *Sign Support Standard Plans*. Blast clean and galvanize steel structure components in accordance with section 716. Field verify the correctness of bridge sign connection strut lengths for fabrication. The Engineer must approve the strut lengths prior to commencing fabrication.
4. **Signs.** Fabricate in accordance with the *Michigan Standard Highway Signs Manual* or as required by traffic sign graphic design layout plans.

B. **Delineators.** Remove posts, including reflectors or sheeting, in accordance with subsection 810.03.U. Dispose of materials in accordance with subsection 204.03.B.

1. **Installing Rigid Delineator Posts.** Drive steel posts plumb into the ground in accordance with the *MDOT Standard Plan R-127* series. Do not bend the post or damage the top.
2. **Installing Flexible Delineator Posts.** Install flexible delineator posts with the required anchoring accessories in accordance with the post manufacturer's directions. Do not bend or damage the posts. Install the flexible post plumb with its reflective sheeting perpendicular or radial to oncoming traffic. Replace posts or sheeting damaged during installation at no additional cost to the Department.
3. **Reflectors.** Mount reflectors as shown on the *MDOT Standard Plan R-127* series. Reflectors and mounting hardware must be in accordance with subsection 919.03.

4. **Reflective Panels.** Provide and install reflective panels to sign supports with a minimum width of 2 inches with the length measured from the bottom of the sign as follows:

   3 feet – Signs with 4 feet bottom height and combination signs on same supports.

   6 feet – All other signs and applications.

   Install the reflective material per the manufacturer's installation instructions. Install the reflective panel to the sign support using stainless steel fasteners.

C. **Steel Post Sign Supports and Square Tubular Steel Sign Supports.** Drive or embed posts so sign faces and supports are within $^{3}/_{16}$ inch of plumb over 3 feet. Place posts within 2% of the plan distance, as measured from center-to-center of posts.

   Do not damage the top of posts during driving. Install steel sign supports and square tubular steel sign supports in accordance with MDOT's *Sign Support Standard Plans*.

D. **Wood Post Sign Supports.** Erect wood sign support posts to ensure that sign faces and supports are within $^{3}/_{16}$ inch of plumb over 3 feet. Place the posts within 3% of the plan distance, as measured from center-to-center of posts.

   For wood post sign supports that do not require pre-drilled holes, place the end with the most severe strength defects on the top. The Engineer will not require forms for concrete, provided the Contractor prevents earth from falling into the limits of the excavation.

   The Contractor may use tubular shells in soils where boreholes will not stay open.

E. **Installing Steel Posts Through Concrete.** If installing steel sign posts, including square tubular steel sign supports or steel delineator posts through existing concrete, drill or saw cut a separate hole through the concrete for each post. Drill or cut post holes no greater than 1 inch larger than the largest cross-sectional dimension of the post. After drilling or sawing, remove the concrete debris from the hole. Clean and dry the area around the hole. Insert the galvanized steel post into the hole and embed to a depth of 3½ feet below the top of concrete grade. Fill the hole around the post with a silicone sealer.

   If installing posts in new concrete, the Contractor may form holes before placing the new concrete.

F. **Installing Wood Posts Through Concrete.** If installing wood sign posts through existing concrete, drill or saw cut a separate hole through the concrete for each post. Drill or cut postholes to a diameter of at least 18 inches. After drilling or sawing, remove the concrete debris from the hole. Clean and dry the area around the hole. Center the galvanized steel sleeve and wood post in the hole.

If installing wood posts in new concrete, the Contractor may form holes before placing the new concrete.

G. **Sign Band.** Provide and install bands to fasten a single sign or route marker cluster bracket to the supports in accordance with MDOT's *Sign Support Standard Plans* SIGN 740 series or as directed by the Engineer.

H. **Concrete Glare Screen and Concrete Median Barrier Connections.** Provide and install sign supports on concrete glare screen or concrete median barrier in accordance with *MDOT's Sign Support Standard Plans*. Place supports so the sign face and post are within $^{3}/_{16}$ inch of plumb over 3 feet.

I. **Foundations for Steel Column Breakaway Sign Supports.** Auger the holes for supports. The Engineer will not require concrete forms, provided the Contractor prevents earth from falling into the limits of excavation.

The Contractor may use tubular shells in soils where boreholes will not stay open.

Place the concrete in accordance with subsection 706.03.H. Hold the stub column in position with a template for at least 24 hours after placing the concrete. Construct the foundation with the top elevation as shown on MDOT's *Sign Support Standard Plans* or as required.

J. **Cantilever and Truss Foundations.** If opening the project or section to traffic before or during construction of cantilever sign support and truss sign support foundations, provide temporary traffic control devices in accordance with section 812. Maintain the temporary traffic control devices at each foundation until completion of the foundation, backfill, and, if required, guardrail installation. Construct the foundation to the top elevation shown on MDOT's *Sign Support Standard Plans* or as required.

1. **Excavation.** Excavate in accordance with subsection 206.03.A.

2. **Forms**. Construct forms in accordance with subsection 706.03.D. The Contractor may omit forms for footings or foundation portions more than 6 inches below the finished earth grade, if the earth outside the neat lines of the foundation shown on the plans does not intrude into the excavation.

3. **Hand Chipping.** Remove unsound or loose concrete with air hammers or other Engineer-approved methods. Salvage existing steel reinforcement in the wall or barrier. Saw cut the area designated for removal to at least ½ inch deep along a line determined by the Engineer.

   Remove the concrete around truss anchor bolts to an area at least 3 inches beyond the perimeter of the anchor pattern and 3 inches below the embedded depth of the anchor bolts, as shown on MDOT's *Sign Support Standard Plans* SIGN 610 series. Remove the concrete from exposed reinforcing steel to provide a clearance of at least ¾ inch behind the steel. Remove loose material and blast clean the exposed surfaces and existing steel reinforcements. Blow out the area with oil-free compressed air.

4. **Existing Steel Reinforcement.** Treat exposed steel reinforcement in accordance with subsection 712.03.I.

5. **Placing Steel Reinforcement.** Place steel reinforcement in accordance with subsection 706.03.E.

6. **Setting Anchor Bolts and Placing Concrete.** Position anchor bolts and place concrete in accordance with subsection 810.03.N.1.

7. **Surface Finish.** Finish exposed surfaces in accordance with section 706.

8. **Curing.** Use a white membrane curing compound except during cold weather. In cold weather, protect the concrete in accordance with subsection 706.03.N.

9. **Backfilling.** Ensure that the Engineer approves the backfill material and compaction method before placing backfill. Backfill in accordance with subsection 206.03.B. Place and compact backfill around the foundation in layers no greater than 9 inches thick

K. **Drilled Piles for Cantilever and Truss Foundations.** Construct drilled piles for cantilever and truss foundations in accordance with section 718.

L. **Cantilever Sign Supports.** Transport and handle cantilever sign supports without damaging the members. Do not lift cantilever box sections by chains or internal truss members. Use nylon slings that wrap the entire cross section and provide at least a two-point pickup for handling the truss sections. Erect cantilever sign supports in accordance with the following sequence:

   1. Place nuts and washers, install upright column without arms, and tension nuts in accordance with subsection 810.03.N.2.

2. For Type E cantilevers, place the arms without the sign on the erected column. Tighten bolts in accordance with the turn-of-the-nut method specified in subsection 707.03.E.6.d. Discard nuts and bolts loosened or removed after full tensioning. The Engineer will not require replacement of tightened bolts that are loosened by tightening adjacent bolts.

3. For Type J cantilevers, align the truss box and truss box splice connection angles in the relaxed position and tighten bolts to a snug tight condition in accordance with subsection 707.03.E.6.c. The lock washers must be fully compressed after snug tightening has been completed. Place the truss box without the sign on the erected column. Align truss box connection flanges with the upright column connection flanges and tension bolts in accordance with the turn-of-the-nut method specified in subsection 707.03.E.6.d.

4. Place the sign panel on the erected arms. Field drill holes in the aluminum mounting supports that receive the sign panel mounting U-bolts to ensure that the final position of the sign panel is level.

5. Upon completion of the cantilever sign support structure erection, stencil the structure number, as shown on the plans, on the vertical support member at least 4 feet, but no more than 6 feet, above the sign structure base plate. Use black urethane spray paint and 2-inch gothic-style font numbers and letters for stenciling. Place the stencil on the side of the structure facing the roadway. Place all stenciling on the vertical support members on the right side of the roadway unless a cantilever is installed on the left side of the roadway per the signing plans. Notify the Engineer in writing upon completion of stencil placement.

M. **Truss Sign Supports.** Transport and handle truss sign supports without damaging the members. Do not lift truss box sections by chains or internal truss members. Use nylon slings that wrap the entire cross section and provide at least a two-point pickup for handling the truss, truss sections, and end supports. Erect truss sign supports in accordance with the following sequence.

1. Place nuts and washers, install upright columns, and tension nuts in accordance with subsection 810.03.N.2.

2. For Type C and D trusses, bring truss box connection flanges into full contact in the relaxed position and tension bolts in accordance with the turn-of-the-nut method specified in subsection 707.03.E.6.c. Discard nuts and bolts loosened or removed after full tensioning. The Engineer will not require replacement of tightened bolts that are loosened by tightening adjacent bolts. Place the truss box, without the

sign, on the erected columns. Align the truss box on the upright columns and connect with U-bolts.

3. For Type E trusses, align the truss box and truss box splice connection angles in the relaxed position and tighten bolts to a snug tight condition in accordance with subsection 707.03.E.6.c. The lock washers must be fully compressed after snug tightening has been completed. Place the truss box, without the sign, on the erected columns. Align truss box connection flanges with the upright column connection flanges and tension bolts in accordance with the turn-of-the-nut method specified in subsection 707.03.E.6.d.

4. Place the sign panel on the erected truss boxes. Field drill holes in the aluminum mounting supports that receive the sign panel mounting U-bolts to ensure that the final position of the sign panel is level.

5. Upon completion of the truss sign support structure erection, stencil the structure number, as shown on the plans, on the vertical support member at least 4 feet, but no more than 6 feet, above the sign structure base plate. Use black urethane spray paint and 2-inch gothic-style font numbers and letters for stenciling. Place the stencil on the side of the structure facing the roadway. Place all stenciling on the vertical support members on the right side of the roadway. Notify the Engineer in writing upon completion of stencil placement.

Load the truss to prevent vibration during erection. If the roadway is open to traffic, load the truss by installing the permanent signs or blank sign panels. If the roadway is closed to traffic, the Contractor may load the truss with sandbags. Fasten temporary loads and leave in place until installation of permanent signs.

N. **Anchor Bolts for Sign Support Structures and Lighting**

1. **Anchor Bolt Installation.** Place and hold anchor bolts plumb and aligned using a steel template. Secure the template before placing the concrete and leave in place at least 24 hours after concrete placement. Place concrete in accordance with 706.03.H and finish smooth and horizontal. Do not erect the sign support until the concrete attains 70% of the minimum 28-day compressive strength or until test beams or cylinders attain a flexural strength of 500 psi.

   The Engineer will reject a foundation if the anchor bolts are out of position or greater than 1:40 out-of-plumb. Do not bend anchor bolts to straighten, move into position, or alter the structure base plate.

2. **Anchor Bolt Tightening.** Mark the flange and each nut and anchor to reference the required rotation.

Place the bottom leveling nuts and washers onto the anchor bolts and thread down as close to the concrete foundation as possible. Level the leveling nuts, keeping them as close to the concrete foundation as possible. The distance from the top of the concrete foundation to the bottom of the leveling nuts must not exceed 1 inch. Place the upright column on to the anchor bolts and bring all leveling nuts into full bearing with the bottom of the structure base plate.

Apply beeswax, or an Engineer-approved equivalent, to the bearing face and threads of the top nuts. Place the top nuts and washers onto the anchor bolts and tighten loosely with a wrench or by hand. Ensure that the top nuts and leveling nuts fully bear on the structure base plate.

Tighten anchor nuts to a snug condition as defined below.

Apply beeswax, or an equivalent, to the top nut bearing face and threads before placing on the anchor. Tighten top nuts to a snug condition, defined as follows:

a. **Snug Condition.** The tightness attained by the full effort of a person using a wrench with a length 14 times the diameter of the anchor bolt but at least 18 inches. Apply the full effort as close to the end of the wrench as possible. Pull firmly by leaning back and using entire body weight on the end of the wrench until the nut stops rotating. Use at least two separate tightening passes. Tighten the top nuts first and sequence the tightening of each pass so the opposite side nut will be tightened until all the top nuts in that pass are snug. After all top nuts are tightened, repeat the procedure to tighten the bottom nuts. If present, lock washers must be fully compressed once tightening is complete.

   Check the snug tightness of the top nuts in the presence of Department personnel ensuring that snugged nuts meet the torque requirements in Table 810-1.

   Once a snug tight condition is verified, use a hydraulic wrench or a calibrated torque wrench to rotate the top nuts an additional one-third turn. Ensure that the hydraulic wrench or calibrated torque wrench has a current traceable accredited calibration. The calibration interval is 1 year unless otherwise approved by the Engineer. Calibration of the torque wrench must be performed by an accredited laboratory. Accurately mark the structure base plate, nuts, and anchor bolts to reference one-sixth and one-third required rotations. Tighten the nuts in two separate passes, turning the nuts one-sixth of a turn with each pass. Use a tightening

sequence to ensure that the nut opposite the tightened nut is subsequently

Table 810-1:
Anchor bolt Snug Condition Required Torque

Anchor Bolt Diameter (inch)	Torque (lbf-ft)	
	Minimum	Maximum
1	100	200
1¼	200	400
1½	300	600
1¾	400	600
2	500	700
2¼	700	900
2½	800	1,000
1¼	200	400

tightened. Do not allow the leveling nuts to rotate during top nut tightening. Once the tightening is complete, mark the upright column with the wrench operator's initials and the date of tightening.

Hydraulic wrench or calibrated torque wrench must have a calibration chart showing conversions between psi and lbf-ft throughout the entire range.

3. **Anchor Bolt Testing.** Check the tightness of the top nuts in the presence of Department personnel a minimum of 48 hours after the additional one-third turn. Using a hydraulic wrench or calibrated torque wrench, apply torque to the nuts in accordance with Table 810-2 and verify no movement of the nut occurs. Mark the upright column with the wrench operator's initials and the date of the 48-hour check.

Table 810-2:
Anchor Bolt Final Turn Required Torque

Anchor Bolt Diameter (inch)	Minimum Torque (lbf-ft)
1	300
1¼	630
1½	1,120
1¾	1,820
2	2,770
2¼	4,010
2½	5,550

If the nuts rotate during the 48-hour check, proper anchor bolt tension was not achieved. The ultrasonic testing and calibration procedures that are used by the Department for final acceptance are available upon request.

Tighten the nuts or washers, determined loose by the Department during acceptance procedures, in accordance with this subsection. The Engineer will determine if removal, disassembly, or re-erection of the structure is necessary. If the Department determines that nuts require tightening, after initial installation, remove and reinstall nuts and washers and, if the Engineer determines necessary, remove, disassemble, and re-erect the entire structure at no additional cost to the Department.

The Department will ultrasonically test the anchor bolts for acceptance after the 48-hour check is deemed acceptable. The ultrasonic testing and calibration procedures that are used by the Department for final structure acceptance are available upon request.

O. **Bridge Sign Connections.** Construct steel and concrete bridge sign connections in accordance with MDOT's *Sign Support Standard Plans*.

P. **Bolt Replacement in Retained Bridge Mounted Sign Connections.** Replace bolts connecting the bracket, sign, diaphragm, and hanger to the sign connection. Do not replace bolts in concrete bridge beams or concrete deck fascia.

Provide connection hardware in accordance with subsection 906.07.

Remove and replace bolts, nuts, flat washers, and lock washers that connect the bolted bridge sign connection bracket to the bridge structure fascia beam, one at a time. Replace the bolts in accordance with subsection 707.03.E.6 and tighten using the turn-of-nut tightening method in subsection 707.03.E.6.d.

Q. **Overhead Lane Assignment Structures.** Construct overhead lane assignment structures in accordance with MDOT's *Sign Support Standard Plans* SIGN 760 series. After placement of foundations, steel poles, and steel cables, erect the overhead lane assignment signs in accordance with the following:

1. Connect two angles to each sign: one on the top and one on the bottom;
2. Assemble the cable clamps, oval eye bolts, threaded rod, nuts, and washers on the top side of each sign; and
3. Hang the signs from the top cable and attach the bottom plate to the lower cable using cable clamps.

R. **Signs.** Provide complete signs, free of defects. Provide reflectorized sign faces, smooth and free of dents, wrinkles, and other defects. Provide signs with uniform color and brightness, free of warps or other deformations, and without mottling, streaks, or stains. Replace signs that do not meet the size, font, or legend layout requirements. Replace signs with unacceptable wrinkles, as determined by the Engineer.

The Engineer will allow no more than three patches per sign. Use patches made of the same material as the sign. Extend patches $^{9}/_{16}$ inch beyond the outer edges of the defect. The Engineer will determine the maximum patch size. Do not patch more than 2% of the total number of signs per project. For projects with 100 or fewer signs, the Engineer will determine the maximum number of patched signs.

The Engineer will provide installation date stickers to the Contractor at the preconstruction meeting.

At the time of installation, place an installation date sticker on the back lower portion of the signs. Ensure that the date sticker is fully visible after installation.

Store signs, delivered for use on the project, in accordance with the sheeting manufacturer's recommendations. Replace or repair signs that were damaged, discolored, or defaced during fabrication, transportation, storage, or erection.

Position and fasten signs to the support. Tighten nuts to the bolts, including nylon washers, in contact with reflective sheeting in accordance with the reflective sheeting manufacturer's recommendations. Erect signs clean and free of substances that would hide or obscure portions of the sign face.

Along roadways open to traffic, cover signs with messages not immediately applicable. Cover signs in accordance with subsection 812.03.D.2.

If replacing existing signs on project sections open to traffic, remove existing signs after erecting new signs visible to motorists. Remove replaced signs and supports from the right-of-way within 7 days. Remove signs and supports in accordance with subsection 810.03.U. Leave existing overhead signs in place until the installation of new signs. Retain existing signs, not shown on the plans, unless otherwise directed by the Engineer.

Do not install signs behind obstructions. Prune vegetation obstructing signs.

Remove packaging and protective materials from sign panels and clean the exposed sign faces in accordance with the manufacturer's specifications. Remove and dispose of excess material. If sign construction disturbs the site, level and repair the area.

Install signs and supports in accordance with the tolerances specified in this subsection.

1. **Extra Holes.** The Engineer will allow no more than two extra holes per sign. Patch extra holes on the front and back sign surfaces. Use patch material of the same reflectivity, color, and age as the reflective sheeting on the sign. Apply patches in accordance with the sheeting manufacturer's recommendations.

2. **Offset.** Erect signs within 2 feet of the location shown on the plans, but do not erect signs closer to the edge of the traveled way than the distance shown on the plans or as specified in MDOT's *Sign Support Standard Plans* SIGN 120 series.

3. **Bottom Height.** Erect signs with the bottom height in rural areas within 6 inches of the height shown on the plans, and in urban areas, within 6 inches above the bottom height shown on the plans.

4. **Sign Location**. Do not change the location of regulatory, gore, or no passing zone signs or signs on cantilevers, trusses, and bridge connections without the Engineer's approval.

   Place advance warning signs within 10 feet longitudinally from the location shown on the plans. Place the advance warning signs at least the minimum longitudinal distance specified in the MMUTCD.

   Place other signs within 20 feet, longitudinally, of the location shown on the plans.

5. **Gaps.** Ensure that gaps between plywood sheets do not exceed $^{1}/_{16}$ inch.

6. **Wedges.** Limit wedge thickness to between ¾ inch and 1 inch.

7. **Unacceptable Wrinkles.** Replace signs with the following defects:

   a. Wrinkles ending at an outside edge of the sign;

   b. Wrinkles greater than 3 inches long; or

   c. Wrinkles that split or damage the sheeting.

S. **Installing Department Supplied Sign.** Transport signs, supplied by the Department, from the location shown on the plans to the project. Notify the Department contact person at least 72 hours before picking up the sign.

T. **Hanger Mounts and Wall Mounts.** Fabricate and install hanger and wall mounts including drilling for anchor installation in accordance with sections 707, 712, and 810, MDOT's *Sign Support Standards*, or as required. Test the structural anchor system in accordance with section 712.

U. **Removal of Signs and Sign Supports.** Remove and salvage cantilever and truss sign supports using the methods required for erecting the supports. Remove, haul, and stockpile Type I signs, cantilevers, trusses, column breakaways, bridge connections, and all associated attaching or fastening hardware at the offsite location required. Coordinate delivery of salvaged items with the Department contact person at least 72 hours before transporting to the Department property location as shown on the plans or as directed by the Engineer.

Take ownership of remaining signs, supports, and associated attaching or fastening hardware.

Pull, do not cut, sign and delineator supports requiring removal or replacement. If the Engineer determines that posts or columns cannot be pulled, cut off at least 12 inches below grade and fill the hole. For sign supports in concrete surfaces, cut the support at the surface. Fill in the hole with grout or similar material completely. Finish to provide a smooth surface free from irregularities.

Remove bridge sign connections, welded to steel beams, by flame cutting. Leave a ¼-inch projection from the web. Grind the projection flush with the surface of the web to a surface roughness no greater than 250 micro inches per inch root mean square. Coat the surface with an Engineer-approved zinc-rich primer after grinding.

To remove bridge sign connections, bolted to steel beams, dismantle the bridge sign in reverse order from installation. If replacing an existing sign support, fill unused holes in bridge steel beams with galvanized high-strength bolts, installed in accordance with subsection 707.03.E.6.

Remove bridge mount sign connection anchor bolts to concrete surfaces by unbolting or cutting if the connection detail is not to be reused. Flame cutting of sign connections is prohibited. Cut and grind flush anchor bolts embedded in the concrete. Core drilling for anchor bolt or insert removal is prohibited. Coat the exposed ends of the anchor bolts with an epoxy grout or a tinted organic zinc-rich primer in accordance with section 715.

If removing trusses or cantilevers, separate the truss box or cantilever arms without damaging the unit. Remove the truss box or cantilever arms before removing end supports. Remove end supports in reverse order

from installation. Do not torch cut uprights of the end supports for removal. Do not scratch, scorch, or nick the cantilever or truss members.

V. **Removal of Sign Support Foundations.** Remove foundations to 12 inches below the ground surface and backfill in accordance with subsection 204.03.C. If the contract requires complete removal of a foundation, remove sign support foundations in accordance with subsection 204.03.A.3 and backfill in accordance with subsection 204.03.C after new foundation is installed

Dispose of concrete and other deleterious material in accordance with subsection 205.03.P. Topsoil, seed, and mulch the removal area in accordance with subsection 816.03.

W. **Erection of Salvaged Sign Supports and Signs.** Handle and store signs and sign supports, salvaged for use on the project, in accordance with subsection 810.03.R. Transport, store, and erect salvaged supports and signs in accordance with subsection 810.03.U. Replace salvaged signs with damage or defects with new signs at no additional cost to the Department.

Upon erection of salvaged sign supports, stencil the structure support per subsections 810.03.L and 810.03.M as applicable.

810.04. Measurement and Payment

Pay Item	Pay Unit
Delineator Reflector, (color)	Each
Post, (type), Delineator	Each
Delineator, Reflective Sheeting, __ inch by __ inch, (color)	Each
Post, Steel, __ lb	Foot
Post, Wood, __ inch by __ inch	Foot
Post, Wood, __ inch by __ inch, Direct Embedment	Foot
Post Hole Through Conc for Wood Post	Each
Post Hole Through Conc for Steel Post	Each
Band, Sign	Each
Median Barrier Connection, Conc, Perforated Steel Square Tube	Each
Glare Screen Connection, Conc, Perforated Steel Square Tube	Each
Perforated Steel Square Tube Breakaway System	Each
Fdn, Breakaway, W8 by (wt/ft)	Each
Fdn, Cantilever, Type __	Each
Fdn, Truss, Type __	Each
Fdn, Truss Sign Structure Type __, __ inch Dia, Cased	Foot
Fdn, Truss Sign Structure Type __, __ inch Dia, Uncased	Foot
Fdn, Cantilever Sign Structure Type __, __ inch Dia, Cased	Foot
Fdn, Cantilever Sign Structure Type __, __ inch Dia, Uncased	Foot

Column, Breakaway, W8 by (wt/ft) ..... Each
Cantilever, Type __ ..... Each
Truss, Type __, __ foot ..... Each
Sign, Type __ ..... Square Foot
Bridge Sign Connection, Conc, Type __ ..... Each
Bridge Sign Connection, Steel, Type __ ..... Each
Bridge Sign Connection, Bolt Replacement ..... Each
Overhead Lane Assignment Structure ..... Each
Installing MDOT Supplied Sign, Type __ ..... Each
Sign, Type __, Rem ..... Each
Fdn, Wood Support, Rem ..... Each
Fdn, Entire, Cantilever, Rem ..... Cubic Yard
Fdn, Entire, Truss, Rem ..... Cubic Yard
Fdn, Column Breakaway, Rem ..... Each
Fdn, Cantilever, Rem ..... Each
Fdn, Truss, Rem ..... Each
Cantilever, Rem ..... Each
Truss, Rem ..... Each
Bridge Sign Connection, Type __, Rem ..... Each
Transporting Salv MDOT Materials ..... Lump Sum
Cantilever, Type __, Erect, Salv ..... Each
Truss, Type __, __ foot, Erect, Salv ..... Each
Sign, Type __, Erect, Salv ..... Each
Truss Connection, Hanger Mtd ..... Each
Sign Connection, Wall Mtd ..... Each
Reflective Panel for Permanent Sign Support, __foot ..... Each
Fdn, Perforated Steel Square Tube Sign Breakaway System, Rem ..... Each
Delineator, Rem ..... Each
Bracket, H ..... Each

The unit prices for fabricated items include the cost of providing dimensional information for the relevant fabricated item.

A. **Sign Posts**

1. **Post, Steel or Post, Wood.** The Engineer will measure sign supports to the nearest commercial length required. The Department will not pay for the portion of posts installed deeper than the depth shown on the plans, unless authorized by the Engineer.

   The unit price for **Post, Wood** of the type required includes the cost of providing and installing wood post sign supports set in a sleeve in concrete.

2. **Post Holes Through Concrete for Steel Posts or Post Holes Through Concrete for Wood Posts.** The unit prices for **Post Hole**

Through Conc for Steel Post and **Post Hole Through Conc for Wood Post** include the cost of drilling or saw cutting a hole in existing concrete, silicone sealer, cleaning the site, and replacing damaged concrete.

If installing posts in new concrete, the unit prices for **Post Hole Through Conc for Steel Post** and **Post Hole Through Conc for Wood Post** include the cost of the optional method of forming.

3. **Reflective Panel for Permanent Sign Supports.** The unit price for **Reflective Panel for Permanent Sign Supports** includes all labor, materials, and equipment required to fabricate, furnish, and install the reflective panel to the sign supports as depicted on the plans or as directed by the Engineer.

4. **Glare Screen Connection, Conc, Perforated Steel Square Tube or Median Barrier Connection, Conc, Perforated Steel Square Tube.** The unit price for **Glare Screen Connection, Conc, Perforated Steel Square Tube** and **Median Barrier Connection, Conc, Perforated Steel Square Tube** includes all labor, materials, and equipment required to fabricate, furnish, and install the connections in accordance with MDOT's *Sign Support Standards* or as directed by the Engineer.

B. **Foundations**

1. **Foundation, Truss Sign Structure and Foundation, Cantilever Sign Structure.** The Engineer will measure **Fdn, Truss Sign Structure and Fdn, Cantilever Sign Structure** of the diameter required, from the bottom of the drilled shaft to the top of the finished foundation.

   The unit prices for **Fdn, Truss Sign Structure Type __, __ inch Dia, Cased** and **Fdn, Cantilever Sign Structure Type __, __ inch Dia, Cased** include the cost of concrete, slurry, steel reinforcement, permanent casings, anchor bolts, excavation, and disposal of excavated material.

2. **Foundation, Truss Sign Structure, Uncased and Foundation, Cantilever Sign Structure, Uncased.** The unit prices for **Fdn, Truss Sign Structure Type __, __ inch Dia, Uncased** and **Fdn, Cantilever Sign Structure Type __, __ inch Dia, Uncased** include the cost of concrete, slurry, steel reinforcement, temporary casings, anchor bolts, excavation, and disposal of excavated material.

C. **Bridge Sign Connections.** The unit prices for bridge sign connection pay items include the cost of locating connections and constructing and installing the sign supports.

The unit price for **Bridge Sign Connection, Bolt Replacement** includes the cost of bolted bridge connections, including retained diaphragms and hangers on steel bridges, and removing and replacing bolts and associated hardware. Removed bolts and hardware become the property of the Department.

D. **Hanger and Wall Mount Connections.** The unit prices for **Truss Connection, Hanger Mtd** and **Sign Connection, Wall Mtd** include the cost of furnishing, drilling for anchorage, and installing truss and sign connections at the location shown on the plans.

E. **Overhead Lane Assignment Structure.** The unit price for **Overhead Lane Assignment Structure** includes the cost of constructing the foundations for installing structures and lane assignment signs.

F. **Signs.** The Engineer will not deduct corner radii or mounting holes when determining the area of sign faces. The Engineer will calculate the area using the smallest circumscribing rectangle. The Engineer will calculate the area of triangular signs using the area of the circumscribing triangle.

The unit price for **Sign**, of the type required, includes the cost of attaching devices and hardware, including fabricating brackets, erecting signs on supports, pruning vegetation, and site cleanup in accordance with subsection 810.03.R. H brackets will be paid for separately.

The Engineer will measure individual sign bands for payment. The unit price for **Band, Sign** includes the cost of furnishing and installing each sign band.

The unit price for **Sign, Type II** includes the cost of fabricating signs, workmanship, repair, and sealing plywood edges in accordance with subsection 919.02.A.2.

Before final acceptance, replace or repair approved for use and in-use traffic sign installations that are damaged by conditions not caused by the Contractor, as directed by the Engineer.

The Department will pay for replaced items at the contract unit price unless the Contractor justifies that the elapsed time between initial installation and the replacement installation warrants a price adjustment in accordance with Section 103. The Department will pay for repaired items as extra work.

G. **Certification of Structural Steel Plants.** The Department will not pay for costs incurred for the certification of structural steel plants. The

Department will not consider claims by the Contractor or fabricator for delays and inconvenience associated with the certification process.

H. **Installing MDOT Supplied Sign.** The unit price for **Installing MDOT Supplied Sign** of the type required includes the cost of loading the sign at the location shown on the plans, transportation, sign-mounting hardware, and installation.

I. **Removal of Signs and Foundations.** The unit price for **Sign, Rem** of the type required includes the cost of removing supports, sign bands, concrete glare screen connections, or concrete median barrier connections; attaching or fastening hardware; and removing signs from supports and stacking by shape and size.

The unit prices for **Cantilever, Rem** and **Truss, Rem** include the cost of removing cantilever or truss supports.

The unit price for **Bridge Sign Connection, Rem** of the type required includes the cost of removing connection brackets, hardware, and filling unused holes created by the removal; cutting and grinding existing anchor bolts; and grouting and/or coating the exposed ends.

The unit prices for constructing or removing foundations include the cost of placing topsoil, seeding, and mulch and restoring the area.

J. **Transporting Salvage MDOT Materials.** The unit price for **Transporting Salv MDOT Materials** includes the cost of loading, transporting, unloading, and stacking salvaged materials at the off-site location shown on the plans or directed by the Engineer.

K. **Cantilever, Erect, Salvage** and **Truss, Erect, Salvage**. The unit prices for **Cantilever, Erect, Salv** and **Truss, Erect, Salv** of the types required include removing, loading, transporting, unloading, storing after removal, and erecting the salvaged sign support on a new or existing foundation, as shown on the plans.

L. **Sign, Erect, Salvage.** The unit price for **Sign, Erect, Salv** of the type required includes removal, the cost of storing signs after removal and loading, transporting, unloading, and erecting the salvaged sign on a new sign support or existing sign support, as shown on the plans, and attaching devices, and hardware, including brackets.

The Department will pay separately for new sign supports.

M. **Delineators.** The unit price for **Post, (type), Delineator** includes providing and installing the delineator post of the type specified.

N. **Bracket.** Provide and install brackets to fasten multiple signs or route marker cluster bracket to the supports in accordance with MDOT's *Sign Support Standard Plans* SIGN 740 series, or as directed by the Engineer.

Section 811. Permanent Pavement Markings

811.01. Description

This work consists of providing and applying retroreflective permanent pavement markings in accordance with the MMUTCD. Provide markings, shapes, spacing, and dimensions that conform to MDOT's *Pavement Marking Standard Plans*.

811.02. Materials

Provide materials in accordance with the following sections:

Provide the Material Safety Data Sheets to the Engineer for required materials and supplies. Dispose of unused material and containers in accordance with the federal Resource Conservation and Recovery Act (RCRA) of 1976 (42 USC 6901 et seq.) and Part 111, Hazardous Waste Management, of the Natural Resources and Environmental Protection Act (MCL 324.11101 et seq.).

Provide samples of permanent pavement marking materials on Department request.

Ship all material to the job site in sturdy containers marked in accordance with subsection 920.01.A.

Submit to the Engineer prior to the start of work the manufacturer's recommended application rate of the wet reflective (WR) optics and the liquid applied pavement marking binder to be used on the project. If the manufacturer's recommended application rate differs from the specified rate in Table 811-1, the manufacturer's recommended rate supersedes the table values.

Table 811-1:
Pavement Marking Material Application Rates per Mile[(a)(b)]

Binder Type	Wet Binder Thickness without Beads (mil)	Min. Dry Thickness with Beads (mil)	Binder Volume/ Weight and Bead Weight	Line Type							
				Broken				Solid			
				4 inch	6 inch	8 inch	12 inch	4 inch	6 inch	8 inch	12 inch
Waterborne	15	20	Binder (gal)	4.2	6.2	8.3	12.4	16.5	24.7	33	49.4
			Bead (lb)	34	50	67	100	132	198	264	396
Low temperature waterborne	15	20	Binder (gal)	4.2	6.2	8.3	12.4	16.5	24.7	33	49.4
			Bead (lb)	34	50	67	100	132	198	264	396
Regular dry	15	20	Binder (gal)	4	6	8	12	16	24	32	48
			Bead (lb)	24	36	48	72	96	144	192	288
Thermoplastic	90	110	Binder (lb)	435	653	870	1,305	1,740	2,610	3,480	5,220
			Bead (lb)	50	75	100	150	200	300	400	600
Sprayable thermoplastic	30	40	Binder (lb)	140	210	280	420	560	840	1,120	1,680
			Bead (lb)	50	75	100	150	200	300	400	600
Modified epoxy	20	45	Binder (gal)	5.5	8.25	11	17	22	33	44	66
			Bead (lb)	As directed by the manufacturer				As directed by the manufacturer			
Polyurea	20	45	Binder (gal)	5.5	8.25	11	17	22	33	44	66
			Bead (lb)	As directed by the manufacturer				As directed by the manufacturer			

(a) Binder yield indicates the amount (gal or lbs/mile) needed to produce the required mil thickness without drop on beads.
(b) Bead yield indicates the amount (lbs/mile) of drop on beads required for the given binder.

811.03. Construction

A. **Equipment.** Provide self-propelled equipment certified by the Department in accordance with MDOT's *Equipment Certification Guidelines – Pavement Markings*. Certification is effective for 2 years. The Engineer may approve other equipment for special markings or areas inaccessible to self-propelled pavement marking equipment.

Apply longitudinal lines using certified self-propelled pavement marking equipment. Operate marking equipment at no greater than the certified speed. The Engineer will assume that a striper operating above the certified working speed has operated at that speed for the entire day.

The Department may inspect the equipment at any time.

Use equipment capable of uniformly applying material to the required length and width.

Provide equipment for placing centerlines capable of applying three 4-inch-minimum-width lines on a two-lane road in one pass. If applying multiple centerlines, use three spray guns positioned 6 inches on center. For two-lane freeways, apply the lane line from the left lane. For freeways with at least three lanes, apply the right lane line with the right edgeline when the right lane line and edgeline are the same material.

Use an easily adjusted, dashing mechanism to retrace existing lane or centerline markings.

Use a self-propelled pavement marker capable of marking pavement in either direction on a roadway. Use a continuous skip cycle. Do not zero or return the cycle control unit to the beginning or start of a new cycle.

Provide a distance meter to measure the length of each line.

The Engineer may check the calibration of metering devices at any time. If the Engineer determines that the equipment is unsatisfactory, use other methods approved by the Engineer.

Use equipment for placing hot-applied thermoplastic and sprayable thermoplastic material that can maintain the temperature recommended by the material manufacturer.

Allow time for the Engineer to inspect traffic control devices as shown in MDOT's *Pavement Marking Convoy Typicals* prior to marking applications. Correct traffic control devices not approved by the Engineer before continuing. If applying markings on a roadway closed to traffic, the traffic control devices specified in MDOT's *Pavement Marking Convoy Typicals* are not required, unless otherwise directed by the Engineer.

B. **General.** The Department will not provide storage buildings or space for permanent pavement marking equipment or materials.

If pavement marking plan sheets and/or Witness, Log are included in the project, the markings must be laid out by the Contractor prior to the permanent markings being applied. Layout is considered incidental to placement of permanent pavement markings. Provide the Engineer documented notice at least 2 calendar days prior to the Contractor's pavement marking crew arriving onsite to layout or layout and stripe. The onsite Engineer must approve the layout prior to the marking application. Notify the Engineer if it is discovered during layout that the pavement width or geometry has been altered or is different from the planned or logged configuration. The Contractor and Engineer will discuss and document the resolution for marking layout in such areas. If pavement marking plans and/or Witness, Log are not in the project, it is the responsibility of the Engineer to provide layout for the permanent pavement markings.

For any portion of the project that pavement marking plan sheets or details are included, layout the permanent pavement markings according to the pavement marking plans. If the contract calls for Witness, Log, the Contractor must witness and log the existing markings in accordance with the following.

Provide a pavement marking layout plan consisting of aerial imagery, computer-generated drawings and/or hand sketches with legibly handwritten or documented dimensions. When using aerial imagery, the pavement markings must be sketched in for any sections where they are not clearly visible. Required dimensions include turn lane storage lengths, taper lengths, stop bar location as measured from the centerline of the intersection or the crosswalk markings (if present), symbol and legend locations, cross hatching location and spacing, longitudinal line style changes, and any other dimensions required to return markings to the pre-construction configuration. The layout plan must additionally indicate lane widths of all lanes, shoulders, bike lanes, and other features at all transition points where these elements are added and/or removed and at every ½-mile interval where there are no changes to pavement widths and/or the pavement marking configuration.

Provide the pavement marking layout plan to the Engineer prior to pavement removal operations and/or any pavement markings being disturbed. If any changes are needed, the Engineer will mark up a copy of the pavement marking layout plan and initial any changes. The Engineer will provide any markups and documented approval of the pavement marking layout plan to the Contractor within 10 calendar days of initial receipt.

The pavement surface must be clean and dry before applying pavement markings. Air blast to remove material that prevents pavement markings from adhering to the pavement surface. Remove debris and dead animals from the line track.

For solid lines, apply 4-inch lines, 6-inch lines, 8-inch lines, and 12-inch lines no greater than ¼ inch wider than the required width. Apply solid lines with no gaps or spaces. Apply a double line as two solid lines or one solid line and one broken line.

For new broken lines, apply 12½-foot-long lines. Leave a 37½-foot gap between new broken lines. Continue this 50-foot cycle of broken line and gap, as shown on the plans. Apply new lines at the required location within a lateral tolerance of 1 inch and no greater than 4 inches longer than the required length.

When applying centerline and lane lines on new construction, retrace at least five existing adjacent skips to match the existing pavement marking cycle.

Retrace existing pavement markings using lines equal to the width and length of the original markings. For existing 4-inch, 6-inch, 8-inch, or 12-inch-wide lines, retrace no greater than ¼ inch wider than the existing line. If existing lines exceed the nominal widths, ensure that the total line widths, existing and retraced, do not exceed 5 inches, 7 inches, 9 inches, and 13 inches.

For existing 12½-foot broken lines, place the retraced line to a longitudinal tolerance of no greater than 4 inches longer than the existing line. If existing lines exceed 12½ feet long, ensure that broken line lengths for existing and retraced lines do not exceed 13 feet.

Mix liquid materials during application. Do not thin materials. Uniformly apply pavement marking material at the rates shown in Table 811-1.

The Engineer will determine the application rates by dividing the quantity of material used by the length of the line placed. The Engineer may check application rates at start up and during work without prior notice to the Contractor.

Load pavement marking materials on the pavement marking machine without interfering with or delaying traffic. Operate striping equipment to prevent traffic from crossing the uncured markings. Prevent vehicles from being sprayed.

Position bead guns to direct beads into the line material and provide a uniform application of beads.

If applying markings in off-road areas open to traffic, including rest areas, roadside parks, and car pool lots, maintain traffic to prevent vehicles from crossing the uncured markings.

The Department does not require glass beads for waterborne pavement marking material for parking stalls and cross hatching if marking rest areas, roadside parks, and car pool lots. Beads are not to be placed in liquid shadow markings.

Apply pavement marking lines straight or in uniform curvature. Markings must be sharp and well defined and free of uneven edges, overspray, and other visible defects, as determined by the Engineer. Remove pavement markings outside the required tolerances and re-apply in the correct locations. Re-apply unprotected pavement markings damaged by traffic and remove tracked lines at no additional cost to the Department.

C. **Removal.** If required, remove existing pavement markings or in accordance with subsection 812.03.F.

When surface applying pavement markings on new concrete, remove the curing compound in accordance with subsection 812.03.F.

If removing existing special markings, including legends, symbols, crosswalks, cross hatching, and stop bars, in advance of placing new special markings, install the new markings within 5 working days of removing the existing markings.

When removing markings, collect and dispose of removed material.

D. **Application, Temperature, and Seasonal Restrictions.** Ensure that the material application rates in Table 811-1, the temperature and seasonal application restrictions in Table 811-2, and the additional requirements detailed in this subsection for specific materials are met when applying any material, unless directed by the Engineer. Document moisture testing and provide results to the Engineer.

1. **Waterborne.** The Engineer will not decide the suitability of specific days for the application of waterborne paint. Re-apply lines damaged by weather at no additional cost to the Department.

   The Contractor may place waterborne pavement markings immediately on new HMA pavement.

   For micro-surfacing projects, place waterborne pavement markings on the surface course before opening to traffic. Allow the surface to wear for at least 30 days or as determined by the Engineer before applying the second application of waterborne or a first application of sprayable thermoplastic.

Table 811-2:
Minimum Material Placement Temperature and Seasonal Restrictions[a]

Material	Minimum Air Temperature [b]	Minimum Pavement Temperature[c]	Date	
			Start	End
Waterborne	50°F	50°F	May 1	Oct. 15
Low temperature waterborne	35°F	35°F	Oct. 1	May 1
Regular dry	25°F	25°F	Oct. 1	May 1
Cold plastic tape with contact cement	60°F	60°F	May 1	Oct. 15
Cold plastic tape – primerless – without surface preparation adhesive	60°F	60°F	Jun. 1	Sept. 1
Cold plastic tape – primerless – with surface preparation adhesive	40°F	40°F	Apr. 15	Nov. 15
Thermoplastic	50°F	50°F	May 1	Nov. 1
Sprayable thermoplastic	50°F	50°F	Apr. 15	Nov. 15
Polyurea	40°F	40°F	Apr. 15	Nov. 15
Modified epoxy	40°F	40°F	Apr. 15	Nov. 15
Preformed thermoplastic	35°F	35°F	Apr. 15	Nov. 15

(a) See text for more detailed information.
(b) Temperature must meet minimum and be rising.
(c) Pavement must be dry.

Waterborne paint may be used outside the specified dates and temperatures only when approved by the Engineer.

2. **Low Temperature Waterborne.** If seasonal limitations prevent placement of waterborne paint, the Engineer may approve low-temperature waterborne paint.

   Wait at least 5 days after placing the pavement surface before applying low-temperature, waterborne pavement markings to new HMA wearing surface. The Engineer may waive the 5-day waiting period.

3. **Regular Dry Paint.** If seasonal limitations prevent the placement of waterborne paint, the Engineer may approve regular dry paint.

   Wait at least 14 days after placing the pavement surface before applying regular dry pavement markings to new HMA wearing surface. The Engineer may waive the 14-day waiting period.

4. **Cold Plastic.** Prepare the pavement surface and apply the cold plastic tape in accordance with the manufacturer's specifications.

   Remove curing compound from new concrete surfaces before applying cold plastic tape. For pavements with two or more layers of

existing overlay cold plastic marking material or any other non-compatible materials, remove the existing marking material before installing the new cold plastic markings.

Install cold plastic tape symbols, legends, crosswalks, cross hatching, and stop bars, as shown on the MDOT Standard Plans, unless otherwise required in the plans.

a. **With Contact Cement**. Apply contact cement recommended by the cold plastic marking manufacturer and approved by the Department. Mix contact cement during application. Do not thin the contact cement. Allow time for solvents to evaporate from the adhesive before applying the cold plastic marking. Apply the contact cement by a method recommended by the manufacturer and ensure that it is beneath the entire marking.

   Provide non-adhesive backed cold plastic for stop bars and crosswalks. Provide adhesive-backed cold plastic for all other special markings.

   Immediately after placement, roll transverse and special markings at least four times with a roller weighing at least 200 pounds. The Engineer will not require additional rolling for longitudinal applications if the equipment for installing the line is equipped with a roller.

b. **Primerless – Without Surface Preparation Adhesive**. Ensure that the weather has been dry for at least 24 hours and that the pavement surface is dry before applying the primerless cold plastic tape marking. Clean the pavement surface using an air compressor with at least 185 cfm air flow and 120 psi. On all pavement surfaces, prevent damage to transverse and longitudinal joint sealers.

   Immediately after placement, roll transverse and special markings at least six times with a roller weighing at least 200 pounds. The Engineer will not require additional rolling for longitudinal applications if the equipment installing the line is equipped with a roller.

c. **Primerless – With Surface Preparation Adhesive**. Use surface preparation adhesive on all primerless cold plastic tape as recommended by the manufacturer or as shown on the plans.

   Ensure that the weather has been dry for at least 24 hours and that the pavement surface is dry before applying the primerless cold plastic tape marking. Clean the pavement surface using an air compressor with at least 185 cfm air flow and 120 psi. On all

pavement surfaces, prevent damage to transverse and longitudinal joint sealers.

Immediately after placement, roll transverse and special markings at least six times with a roller weighing at least 200 pounds. The Engineer will not require additional rolling for longitudinal applications if the equipment installing the line is equipped with a roller.

5. **Thermoplastic.** The pavement must be free of excess surface and subsurface moisture that may affect bonding. The Engineer will not decide the suitability of specific days for the application of thermoplastic.

   Heat and apply the thermoplastic material within the temperature range recommended by the manufacturer.

6. **Sprayable Thermoplastic.** The pavement must be free of excess surface and subsurface moisture that may affect bonding. The Engineer will not decide the suitability of specific days for the application of sprayable thermoplastic.

   Heat and apply the sprayable thermoplastic material within the temperature range recommended by the manufacturer.

   On projects calling for 10,000 feet or less (per color) of sprayable thermoplastic pavement markings to be placed per workday, the Contractor has the option of placing two applications of waterborne paint instead of the sprayable thermoplastic pavement markings. The second application of waterborne is to be completed between 14 and 60 days after the initial application unless otherwise directed by the Engineer.

7. **Polyurea.** The pavement must be free of excess surface and subsurface moisture that may affect bonding. The Engineer will not decide the suitability of specific days for the application of polyurea.

   Surface preparation requirements for special and longitudinal polyurea pavement markings depend on surface conditions.

   Prepare new HMA surfaces and HMA surfaces open to traffic for 10 days or less with no oil drips, residue, debris, or temporary or permanent markings by cleaning the marking area with compressed air.

   Prepare new Portland cement concrete (PCC) surfaces and PCC surfaces free of oil drips, residue, debris, and temporary or permanent markings by removing the curing compound from the area required for pavement markings.

Prepare existing HMA or PCC surfaces that do not have existing markings but may have oil drip areas, debris, or both, by scarifying the marking area using non-milling grinding teeth or shot blasting. The Engineer will allow the use of water blasting to scarify the marking area on PCC surfaces.

Prepare existing HMA or PCC surfaces with existing non-polyurea markings by completely removing non-polyurea markings.

Prepare existing HMA or PCC surfaces with existing polyurea marking and that may have oil drip areas, debris, or both, by using the following methods:

a. For existing polyurea pavement markings, scarify the proposed marking area using non-milling grinding teeth or shot blast.

b. Occasionally, existing polyurea pavement markings require complete removal, which will be determined by the Engineer.

8. **Modified Epoxy.** The pavement must be free of excess surface and subsurface moisture that may affect bonding. The Engineer will not decide the suitability of specific days for the application of modified epoxy.

   Surface preparation requirements for special and longitudinal modified epoxy pavement markings depend on surface conditions.

   Prepare new HMA surfaces and HMA surfaces open to traffic for 10 days or less free of oil drips, residue, debris, and temporary or permanent markings by cleaning the marking area with compressed air.

   Prepare new PCC surfaces and PCC surfaces free of oil drips, residue, debris, and temporary or permanent markings by removing the curing compound from the area required for pavement markings.

   Prepare existing HMA or PCC surfaces that do not have existing markings but may have oil drip areas, debris, or both, by scarifying the marking area using non-milling grinding teeth or shot blasting. The Engineer will allow the use of water blasting to scarify the marking area on PCC surfaces.

   Prepare existing HMA or PCC surfaces with existing non-modified urethane markings or non-modified epoxy markings by completely removing non-modified urethane markings or non-modified epoxy markings.

   Prepare existing HMA or PCC surfaces with existing modified urethane pavement markings or modified epoxy pavement markings

and that may have oil drip areas, debris, or both, by using the following methods:

a. For existing modified urethane pavement markings or modified epoxy pavement markings, scarify the proposed marking area using non-milling grinding teeth or shot blast.

b. Occasionally existing modified urethane pavement markings or modified epoxy pavement markings require complete removal, which will be determined by the Engineer.

9. **Preformed Thermoplastic.** The pavement must be free of excess surface and subsurface moisture that may affect bonding. The Engineer will not decide the suitability of specific days for the application of preformed thermoplastic.

   Heat and apply the preformed thermoplastic material as recommended by the manufacturer. Feather all edges of the material with a putty knife while the preformed thermoplastic is still soft.

E. **Second Application.** If the contract requires a second application of permanent pavement markings, complete two applications regardless of initial pavement marking conditions. Complete the second application from 14 to 60 days after initial application in the same calendar year.

   The Contractor may apply the second application before the required 14 days if approved by the Engineer.

F. **Call Back Painting.** The Engineer will provide a prioritized list of locations and limits for call back pavement marking painting.

   Begin call back painting work within 7 days of the Engineer's notification.

G. **Recessed Pavement Marking.** Install a recess (groove) in accordance with the pavement marking material manufacturer's installation instructions. All recessing configurations must be in accordance with the MMUTCD and MDOT's *Pavement Marking Standard Plans*.

1. **Grooving Concrete and Hot Mix Asphalt Pavement**. If there are no markings on the pavement, it is the Contractor's responsibility to layout and groove exactly where the permanent markings will be placed. If there are temporary painted pavement markings in the correct location, use these lines as a template for the grooving operation. If there are existing permanent pavement markings in place, remove them in accordance with subsection 812.03.F prior to grooving operations. The removal of any existing pavement markings will be paid for separately.

Use equipment and methods approved by the manufacturer of the pavement marking material to be recessed for forming grooves in pavement surfaces. Dry-cut the grooves in a single pass using stacked diamond cutting heads on self-vacuuming equipment capable of producing a finished groove ready for pavement marking material installation.

Ensure that the bottom of the groove has a fine corduroy finish. If a coarse tooth pattern results, increase the number of blades and decrease the spaces on the cutting head until the required finish is achieved.

2. **Placing Recessed Pavement Markings**. Place the pavement-marking material in clean and dry grooves within 24 hours of the grooves being made. Locate the groove so the entire marking can be placed within the groove.

H. **Raised Thermoplastic Rumble Strips.** If required on the plans, furnish and install raised thermoplastic rumble strips on pavement or as directed by the Engineer. Layout the thermoplastic rumble strips, prepare the pavement surface, and apply the rumble strips in accordance with sections 811 and 920 and the following:

1. Clean the pavement surface, making sure the pavement is dry and above the minimum temperature for thermoplastic placement in Table 811-2.

2. Apply the thermoplastic in accordance with the manufacturer's recommendations and as shown in MDOT's *Pavement Marking Standard Plans*.

3. Apply glass beads as recommended by the thermoplastic manufacturer.

I. **Raised Pavement Marker (RPM) Removal.** Remove RPM with equipment approved by the Engineer. During removal, do not disturb pavement more than 3 inches below the surface or more than 3 inches from the perimeter of the marker casting. The Engineer will stop marker removal if damage to the pavement exceeds these limits.

The Engineer will require patching, regardless of milling requirements, unless the Engineer determines that damaged areas do not pose a hazard to traffic. Use an HMA mix approved by the Engineer to patch concrete and HMA pavements that will receive an HMA overlay.

Use a prepackaged, hydraulic, fast-set material for patching structural concrete from the Qualified Products List for patching concrete pavement.

Patch concrete pavement in accordance with the patch material manufacturer's specifications.

Patch HMA pavement, not requiring overlay, with the epoxy adhesive used to attach raised pavement markers to the pavement.

Clean and dispose of debris from RPM removal and patching operations.

J. **Wet Reflective Liquid Applied Pavement Markings.** Furnish and install WR optics and liquid applied pavement marking materials. Place the binder, beads, and WR optics in accordance with the manufacturer's recommendations and sections 811 and 920.

K. **Guide Line Pavement Markings.** Provide all labor, material, and equipment necessary to prepare pavement surface and layout and apply solid or dotted retroreflective guide line pavement markings. When using dotted guide lines to delineate vehicle movements, the guide lines must be recessed. Prepare pavement surfaces by using the following methods:

1. Remove all residue and debris resulting from the preparation work. Control and minimize airborne dust and similar debris generated by surface preparation and cleanup to prevent a hazard to motor vehicle operation or nuisance to adjacent property.

2. Do not damage transverse and longitudinal joint sealers on hot mix asphalt and PCC surfaces when performing removal and cleaning work.

3. Preformed tape markings must be ready for traffic immediately following surface preparation, application and tamping, and markings of other materials must be adequately protected until they can be crossed by traffic without tracking.

4. Replace or repair nonconforming material to the satisfaction of the Engineer, and at no additional cost to the Department.

811.04. Measurement and Payment

Pay Item	Pay Unit
Pavt Mrkg, Waterborne, __ inch, (color)	Foot
Pavt Mrkg, Waterborne, 2nd Application __ inch, (color)	Foot
Pavt Mrkg, Wet Reflective Waterborne, 2nd Application __ inch, (color)	Foot
Pavt Mrkg, Waterborne, for Rest Areas, Parks, & Lots, __ inch, (color)	Foot
Pavt Mrkg, Regular Dry, __ inch, (color)	Foot
Pavt Mrkg, Regular Dry, 2nd Application, __ inch, (color)	Foot
Pavt Mrkg, Sprayable Thermopl, __ inch, (color)	Foot

Pavt Mrkg, Thermopl, __ inch, (color) ..... Foot
Pavt Mrkg, Thermopl, __ inch, Crosswalk ..... Foot
Pavt Mrkg, Thermopl, __ inch, Stop Bar ..... Foot
Pavt Mrkg, Thermopl, __ inch, Cross Hatching, (color) ..... Foot
Pavt Mrkg, Thermopl, Rumble Strip ..... Foot
Pavt Mrkg, Ovly Cold Plastic, __ inch, (color) ..... Foot
Pavt Mrkg, Ovly Cold Plastic, (legend) ..... Each
Pavt Mrkg, Ovly Cold Plastic, (symbol) ..... Each
Pavt Mrkg, Ovly Cold Plastic, __ inch, Crosswalk ..... Foot
Pavt Mrkg, Ovly Cold Plastic, __ inch, Stop Bar ..... Foot
Pavt Mrkg, Ovly Cold Plastic, __ inch, Cross Hatching, (color) ..... Foot
Pavt Mrkg, Ovly Cold Plastic, __ inch, Shadow Tape, Black ..... Foot
Pavt Mrkg, Ovly Cold Plastic, __ inch, Wet Reflective, (color) ..... Foot
Pavt Mrkg, Ovly Cold Plastic, __ inch, Dotted Turning Guide Line, (color) ..... Foot
Pavt Mrkg, Polyurea, __ inch, (color) ..... Foot
Pavt Mrkg, Polyurea, (legend) ..... Each
Pavt Mrkg, Polyurea, (symbol) ..... Each
Pavt Mrkg, Polyurea, __ inch, Crosswalk ..... Foot
Pavt Mrkg, Polyurea, __ inch, Stop Bar ..... Foot
Pavt Mrkg, Polyurea, __ inch, Cross Hatching, (color) ..... Foot
Pavt Mrkg, Modified Epoxy, __ inch, (color) ..... Foot
Pavt Mrkg, Modified Epoxy, (legend) ..... Each
Pavt Mrkg, Modified Epoxy, (symbol) ..... Each
Pavt Mrkg, Modified Epoxy, __ inch, Crosswalk ..... Foot
Pavt Mrkg, Modified Epoxy, __ inch, Stop Bar ..... Foot
Pavt Mrkg, Modified Epoxy, __ inch, Cross Hatching (color) ..... Foot
Pavt Mrkg, Preformed Thermopl, (legend) ..... Each
Pavt Mrkg, Preformed Thermopl, (symbol) ..... Each
Pavt Mrkg, Preformed Thermopl, __ inch, Crosswalk ..... Foot
Pavt Mrkg, Preformed Thermopl, __ inch, Stop Bar ..... Foot
Pavt Mrkg, Preformed Thermopl, __ inch, Cross Hatching, (color) ..... Foot
Pavt Mrkg, Preformed Thermopl, (route) Route Shield, __ foot by __ foot ..... Each
Pavt Mrkg, (binder), __ inch, Shadow Liquid, Black ..... Foot
Pavt Mrkg, Wet Reflective (binder), __ inch, (color) ..... Foot
Pavt Mrkg, (binder), For On-Street Parking, __ inch, White ..... Foot
Pavt Mrkg, (binder), __ inch, Solid Thru Guide Line, (color) ..... Foot
Pavt Mrkg, (binder), __ inch, Solid Turning Guide Line, (color) ..... Foot
Pavt Mrkg, (material), __ inch, Dotted Thru Guide Line, (color) ..... Foot
Rem Curing Compound, for Spec Mrkg ..... Square Foot
Rem Curing Compound, for Longit Mrkg, __ inch ..... Foot
Rem Spec Mrkg ..... Square Foot
Rem Raised Pavt Marker ..... Each

Recessing Pavt Mrkg, Longit ..... Foot
Recessing Pavt Mrkg, Transv ..... Square Foot
Recessing Pavt Mrkg, Guide Line..... Foot
Scarification, for Polyurea Spec Mrkg..... Square Foot
Scarification, for Modified Epoxy Spec Mrkg ..... Square Foot
Witness, Log, $1,250.00 ..... Dollar

A. **General.** The Engineer will not measure the skips in dashed lines. Unless otherwise included in the contract, the cost of traffic control and mobilization is included in the unit prices for other pavement marking placement pay items.

The cost of collecting and disposing of residue generated by the removal of pavement markings and curing compound is included in the unit prices for removal pay items.

The cost of WR optics is included in the unit prices for the applicable pavement marking material.

The Department will not pay separately for the contact cement and adhesives for longitudinal lines, legends, symbols, crosswalks, cross hatching, or stop bars.

The Department will not pay for markings placed by equipment operated at speeds higher than the certified speed.

The Department will not assess liquidated damages if the 5-day waiting period for placing low-temperature, waterborne paint is in effect and the project is complete. The Department will not assess liquidated damages if the 14-day waiting period for regular dry paint is in effect and the project is complete.

Permanent pavement marking materials, temporary retroreflective pavement markings required for traffic control, removal of curing compound, removal of existing permanent pavement markings, and scarification of pavement markings will be paid for separately using the appropriate pay items.

B. **Seasonal Limitations.** The Engineer will apply price adjustments as required by the contract only for the quantity of regular dry or low-temperature waterborne substituted for waterborne paint and placed outside seasonal and temperature limitations. The adjustment applies only to projects that have completion dates after October 1 or have approved extensions of time without liquidated damages beyond October 1. Contractors who are in liquidated damages between October 2 and April 30 are not eligible for the price adjustment.

C. **Sprayable Thermoplastic.** When two applications of waterborne pavement markings are substituted for a single application of sprayable thermoplastic due to placing 10,000 feet or less (per color) per work day, the two applications of waterborne are paid for as a single application of sprayable thermoplastic under the sprayable thermoplastic pay items in the contract.

D. **Pavement Marking Removal.** The Engineer will measure the full removal of special markings based on MDOT's *Pavement Marking Standard Plans*. The Department will pay for partial removal of special markings based on the dimensions of the actual removal area. If full removal of pavement markings is required, the unit prices for **Rem Spec Mrkg** or **Pavt Mrkg, Longit, 6 inch or Less Width, Rem**, and **Pavt Mrkg, Longit, Greater than 6 inch Width, Rem** include the cost of the removal in accordance with subsection 812.04.N.

   If the Contractor removes multiple layers of pavement marking materials, the Department will not pay separately for material removed beyond the first layer.

E. **Curing Compound Removal.** The unit price for **Rem Curing Compound** includes the cost of preparing new PCC for marking application by removing the curing compound. Measurement will be based on MDOT's *Pavement Marking Standard Plans*.

F. **Scarification.** The unit price for **Scarification, for Polyurea Spec Mrkg** and **Scarification, for Modified Epoxy Spec Mrkg** includes the cost of preparing the pavement surface via shot blasting or grinding with non-milling teeth for new pavement markings where pavement markings of the same type are existing. Measurement will be based on MDOT's *Pavement Marking Standard Plans*.

G. **Recessing.** The unit price for **Recessing Pavt Mrkg, Longit; Recessing Pavt Mrkg, Transv** and **Recessing Pavt Mrkg, Guide Line** includes the cost of laying out the exact location of the markings and all work as required to prepare (groove) the pavement surface for recessed pavement markings.

H. **Thermoplastic Rumble Strips.** The Engineer will measure each length of 6-inch by 3/8-inch thermoplastic material, both transverse and longitudinal, to determine the total length of **Pavt Mrkg, Thermopl, Rumble Strip** for payment.

I. **Guide Lines**. The unit price for **Pavt Mrkg, Ovly Cold Plastic, __ inch**, **Dotted Turning Guide Line, (color)** and **Pavt Mrkg, (material), __ inch**, **Dotted Thru Guide Line, (color)** will be for the footage of pavement

marking material placed, not the full path of the turning guide line. Solid guide line pay items are for the full path of the guide line.

J. **Material Deficiency.** The Engineer will compute the quantity of pavement marking material and glass beads applied per unit of measurement at the end of each work day. The Engineer may include an applied length of less than 10 miles in the next day's measurement. The Engineer will determine the material usage based on field measurements and the required application rate specified in Table 811-1.

The Department will reduce the unit price for pavement marking material for material shortages in direct proportion to the deficient material quantity, up to 6%. If the daily deficiency of pavement marking material, or beads, is greater than 6%, the Department will consider the day's work unsatisfactory and will direct the Contractor to reapply the day's markings to the thickness required by the contract at no additional cost to the Department.

K. **Raised Pavement Marker Removal.** The unit price for **Rem Raised Pavt Marker** includes the cost of the required patching material.

Section 813. Slope Protection

813.01. Description

This work consists of constructing precast and cast-in-place (CIP) concrete slope paving, including plain, heavy, and grouted riprap and associated headers.

813.02. Materials

Provide materials in accordance with the following sections:

Cement	901
Granular Material Class II	902
Curing Compound	903
Steel Reinforcement	905
Geotextile Liner	910
Precast Concrete Slope Paving Blocks	913
Riprap	916
Heavy Riprap	916
Concrete, Grade 3000	1004
Mortar, Type R-3	1005

Provide a retarding admixture, selected from the Qualified Products List, if additional time is required between adding water to the concrete mixture and placing the concrete. Do not exceed the manufacturer's recommended maximum initial set time.

813.03. Construction

A. **Base Preparation.** Excavate or fill to the required subgrade. Compact and shape the subgrade for the following:

1. The bottom of the riprap;
2. Precast and CIP concrete slope paving; or
3. The bottom of the granular material layer.

Dispose of the surplus excavated subgrade material in accordance with subsection 205.03.P. Trim the subgrade to the Class A slope tolerances specified in subsection 205.03.N. Construct the granular material layer in accordance with subsection 301.03, except compact the material to at least 90% of the maximum unit weight.

B. **Precast Concrete Slope Paving.** Place concrete in accordance with the weather and temperature limitations specified in subsection 602.03.T when fabricating precast concrete slope paving. Install the precast units on a layer of granular material base. Fill the joints between precast units

with Type R-3 mortar. Moisten the edges of the precast units when placing the mortar. Place mortar beginning at the lower end of the joints and proceeding to the upper end of the joints. Completely fill the joints between the precast units after consolidation. Remove excess mortar from the surface of the slope paving. Cure and protect the mortar in accordance with subsection 813.03.C.3.

C. **Concrete Slope Paving**

1. **Forms.** Use wood or metal forms that are straight and free of warp and capable of resisting deflection during concrete placement. Form the concrete full depth. Stake forms, including slab division forms, to the required line and grade. Provide straight and continuous slab division joints. Form blocks of the dimensions shown on the plans.

2. **Placing and Finishing Concrete.** Place concrete in accordance with the weather and temperature limitations specified in subsection 602.03.T. Maintain a moist base during concrete placement. Place concrete to the required depth in a continuous operation.

   Place concrete within 1½ hours of adding water into the mix. Do not retemper.

   Consolidate the concrete along the faces of the forms. Tamp the concrete surface to remove voids and strike off with a strike board to the required grade and cross section.

   Finish the concrete surface with a wood float. Round the edges and joints to a ¼-inch radius with a Department-approved finishing tool. Remove edging and finishing tool marks with a float and soft bristle brush.

3. **Curing and Protection.** Cure the concrete by applying a transparent membrane curing compound specified in subsection 903.07.B.

D. **Slope Paving Headers.** Use forms for slope paving headers in accordance with subsection 813.03.C.1.

If concrete placement is required below the elevation of the slope paving subgrade, or granular material layer, the concrete may be cast neat to the earth, as approved by the Engineer.

Place steel reinforcement in accordance with subsection 802.03.C. Place and finish slope paving header concrete in accordance with subsection 813.03.C.2. Cure slope paving header concrete in accordance with subsection 813.03.C.3.

E. **Riprap.** Place geotextile liner under the riprap. Place the liner in a key trench at the toe of the slope if the riprap ends at or below a high water

elevation. After the riprap is in place, anchor the geotextile in a key trench at the tops of slopes with a ratio of 1:3 or steeper. Construct the upper key trench to 1½ feet deep or three times the minimum riprap dimension, whichever is greater. Provide a setback between the top of the slope and the upper key trench at least equal to the trench depth. Backfill the upper trench with riprap material unless otherwise directed by the Engineer.

Overlap geotextile seams by at least 2 feet. If laying geotextile horizontally, start at the bottom of the slope and shingle lap additional layers to direct surface runoff. Place riprap onto the geotextile without dumping or dropping riprap into place.

1. **Plain Riprap.** Begin the riprap placement in the trench at the toe of the slope and progress upward. Place individual stones, embedding each stone into the slope, and interlock against adjoining stones. Place random and well-broken joints between consecutive rows of stones. Compact the riprap as construction progresses. Unless using precast concrete blocks, construct riprap at least 18 inches thick, measured perpendicular to the slope.

2. **Grouted Riprap.** Place riprap in accordance with subsection 813.03.E.1. Fill the spaces between the stones with Type R-3 mortar. Place the mortar from joint bottom to top and completely fill the voids between the stones after consolidation. Leave the top surface of the stone exposed. Immediately remove excess mortar with a stiff brush. Cure and protect grouted riprap in accordance with subsection 813.03.C.3.

3. **Heavy Riprap.** Place heavy riprap in accordance with subsection 813.03.E.1. Unless using precast concrete blocks, construct heavy riprap at least 36 inches thick, measured perpendicular to the slope. If using broken concrete, place in two layers with staggered joints and fill voids with smaller pieces of broken concrete, as approved by the Engineer.

813.04. Measurement and Payment

Pay Item	Pay Unit
Slope Paving, Precast Conc	Square Yard
Slope Paving, Conc	Square Yard
Slope Paving Header	Foot
Riprap, Grouted	Square Yard
Riprap, Plain	Square Yard, Ton
Riprap, Plain, LM	Cubic Yard
Riprap, Heavy	Square Yard, Ton
Riprap, Heavy, LM	Cubic Yard

A. **Concrete Acceptance.** Conduct concrete QC as specified in section 1002. The Engineer will conduct QA as specified in section 1003. The Department will pay for this work based on the QA results.

B. **Slope Paving.** The unit prices for slope paving pay items include the cost of admixtures, excavation, and disposal of surplus materials. The unit prices for slope paving pay items also include the cost of granular material, unless the plans include the pay item **Granular Material, Cl**.

C. **Slope Paving Header.** The Engineer will measure **Slope Paving Header** in place, including both sides and the toe.

D. **Riprap.** The unit prices for riprap items include furnishing all materials, equipment, and labor to divert stream flow, clear and prepare grades, excavate and dispose of surplus or unsuitable materials, furnish and place geotextile liner or heavy geotextile liner as applicable, and place the riprap, including headers.

Section 816. Turf Establishment

816.01. Description

This work consists of conducting soil tests, preparing the soil, and placing sod or seed and mulch to permanently stabilize disturbed areas as shown on the plans.

A. Definitions

The following terms apply to this section.

Broadleaf Weed. Any dicotyledonous weedy plant. Broadleaf weeds include, but are not limited to, dandelion, clovers, thistles, and ragweed.

Compost. Mature, stabilized, humus-like material derived from the aerobic decomposition of yard clippings, leaves, and brush with a diameter less than 4 inches.

Dormant Seeding. Seeding placed in late November and December when plant growth ends for the season. Seeds are placed on unfrozen ground and mulched to lie dormant over the winter and germinate the following spring.

Friable. Easily crumbled or pulverized soil.

Friable Condition. Soil in a friable condition is a crumbled, pulverized, worked-up, loosened, or cultivated soil that is free of lumps and clods detrimental to seeding and sodding operations.

Humus. Brown or black material formed by the decomposition of vegetable or animal matter; the organic portion of soil, essential to fertility.

Hydromulching. Spraying mulch combined with water and mulch-anchoring material onto a prepared seed bed.

Hydroseeding. Spraying seed and fertilizer combined with water onto a prepared seed bed.

Muck. Organic matter consisting of decomposed plant material accumulated under conditions of excessive moisture. If organic remains are not identifiable as plant form, the material is considered muck.

Mulch. Material placed over seeding to improve germination by conserving moisture, moderating the soil temperature, and protecting the seed and soil from water and wind erosion.

Mulch Anchor. Glue-type material sprayed over mulch to hold it in place.

Peat. Organic matter consisting of partially decayed plant material accumulated under conditions of excessive moisture. If organic remains are identifiable as plant form, the material is considered peat.

Soil Test. Analysis report of soil nutrient content particle size, pH levels, and organic matter.

Soil Tracking. Horizontal grooves on exposed slopes 1:3 or greater parallel to the contour of the land using tracked construction equipment.

Target Weeds. Weeds the Engineer identifies for removal by spraying or other methods. Target weeds include any plant not included in the specified seed mix.

Turf Reinforcement Mat. Three-dimensional matrix of synthetic or a composite of synthetic and natural materials that is used to permanently control erosion.

816.02. Materials

Provide materials in accordance with the following sections:

816.03. Construction

Establish turf in accordance with this section, the *MDOT Soil Erosion and Sedimentation Control Manual*, and as directed by the Engineer.

A. **Topsoiling.** Before placing topsoil, prepare the foundation. Provide, place, and spread humus bearing topsoil, compost, or both. Use topsoil from within the project limits or from off-site sources meeting the requirements in subsection 917.06. Obtain the Engineer's approval for topsoil placement prior to seeding.

1. **Preparation of Earth Bed.** Seven to 10 days before preparing earth bed, including areas previously mulched or rye seeded for temporary

erosion control, kill existing vegetation by spraying with the non-selective herbicide containing glyphosate.

Construct the earth bed to the required grade and trim.

2. **Placing Topsoil.** Place topsoil meeting the requirements in subsection 917.06. Cover areas requiring seeding or sodding with topsoil, compost, or both, except for slopes constructed of topsoil, muck, or peat.

   Spread topsoil, compost, or both on the prepared areas at least 3 inches deep. Pulverize large clods and lumps. Rake out rocks with a diameter greater than 2 inches, roots, litter, and deleterious material. Dispose of raked-out material in accordance with subsections 205.03.A.3 and 205.03.P.

   Incorporate topsoil and compost into the upper 3 inches of the prepared earth bed. Do not work topsoil or compost if wet. Perform soil tracking prior to seeding on slopes steeper than 1:3. Leave horizontal soil impressions from equipment across the face of the slope, as required by Engineer and noted in the *MDOT Standard Plan R-96* series for soil erosion control measures.

3. **Excavated Topsoil or Salvaged Topsoil.** The Engineer will direct stockpiling excavated or salvaged topsoil within the right-of-way. Maintain the stockpile in a weed-free condition during the entire project duration.

B. **Chemical Fertilizer Nutrient.** Provide and place fertilizer as indicated below.

   In areas requiring sod, uniformly apply granular fertilizer before laying the sod.

   In areas to be broadcast or drill seeded, uniformly apply granular fertilizer to the prepared seed bed.

   Apply the required class of fertilizer to the required locations at the following application rates:

   1. For Class A fertilizer, evenly apply 176 pounds of chemical fertilizer nutrient per acre on a prepared seed bed.
   2. For Class B fertilizer, evenly apply 120 pounds of chemical fertilizer nutrient per acre on a prepared seed bed.
   3. For Class C fertilizer, evenly apply 80 pounds of chemical fertilizer nutrient per acre on established turf.

If using the hydroseeding method, constantly agitate the seed-fertilizer mixture. Do not disk or harrow after placement. Apply fertilizer mixed with seed within 1 hour of mixing.

Remove excess fertilizer from impervious surfaces adjacent to prepared seed and sod beds by sweeping back into beds. Do not use water to flush excess fertilizer into storm drains or surface water. Do not use fertilizer within 15 feet of waters of the state or on frozen or saturated soil.

C. **Seeding.** For each species, provide seed varieties selected from the Qualified Products List. Do not broadcast or hydroseed in conditions that would prevent seed placement as required. Apply turf and specialty seed mixtures in accordance with the mix ratios and seed rates in Table 816-1 and Table 816-2.

Table 816-1:
General Roadside Seed Mix Selection Guide

Turf Seed Mixture		Soil Type	General Location	Seed Rate	Salt Tolerance
TDS	turf dry sandy	Dry sandy to sandy loam	Rural or urban	220 lb/acre	Low to medium
THV	turf heavy soil	Heavy	Rural	220 lb/acre	Medium to high
TUF	turf urban freeway	All types	Urban freeways, blvds., service roads, city streets	220 lb/acre	Medium to high
TGM	turf medium to heavy soil	Medium to heavy	All	220 lb/acre	Low
THM	turf loamy to heavy	Loamy to heavy	Residential and business turf	220 lb/acre	Low to medium

Table 816-2:
Temporary Seeding Mixtures

Seed Mixture		Soil Type	General Location	Seed Rate
CR	cereal rye, <6 mos	All	All	70 lb/acre
TSM 6/24	temporary seeding, 6–24 months	All	All	100 lb/acre
TSM 24+	temporary seeding, >24 months	All	All	200 lb/acre

1. **Permanent Seeding**

   a. **Sowing**. When the seed bed has been properly graded, weeds have been eliminated, and the seed bed has been raked, harrowed, and tracked and is in a friable condition, sow seed with or following the application of fertilizer. Sow seed before applying

mulch. Sow or resow the seed mixture, providing uniform coverage at the rate specified in Table 816-1 or Table 816-2.

Sow using mechanical drills, hydroseeders, or by broadcasting. In areas with 1:4 slopes or flatter, use mechanical drills.

The Department will allow hydroseeding on slopes steeper than 1:4 as approved by the Engineer.

Empty the hydroseeder tank within 1 hour of introducing the seed and/or fertilizer to the tank. Dispose of tank contents that remain in the tank mixed with hydroseeder for longer than 1 hour.

Broadcast in areas requiring resowing or in areas not accessible to a drill or hydroseeder.

The Engineer will visually inspect areas sown for uniformity of application. Resow areas that do not have an average of two seeds per square inch at no additional cost to the Department.

b. **Setting the Seed.** Lightly compact or rake areas sown by broadcast method to incorporate the seed into the top ½ inch of the topsoil. Immediately after setting the seed, mulch in accordance with subsections 816.03.E and 816.03.F.

2. **Temporary Seeding.** Obtain the Engineer's approval for temporary seeding. Place temporary seed only for erosion control or temporary soil stabilization. Do not temporarily seed slopes 1:3 or steeper after placing topsoil; permanently seed these slopes. Sow temporary seed in accordance with subsection 816.03.C.1. Before project completion, replace temporary seeding with permanent seeding as shown on the plans or directed by the Engineer.

3. **Dormant Seeding.** The Engineer will allow dormant seeding in limited areas. Obtain the Engineer's approval prior to dormant seeding. Dormant seed in accordance with subsection 816.03.C.1.

4. **Seasonal Limitations**

a. **Permanent Seeding.** Permanently seed the following locations during the specified periods:

i. Southern Lower Peninsula. South of the north boundary of Township 20 North; April 15 through October 10.

ii. Northern Lower Peninsula. North of the north boundary of Township 20 North; May 1 through October 1.

iii. Upper Peninsula. May 1 through September 20.

b. **Dormant Seeding.** Dormant seed the following locations during the specified periods:

i. Southern Lower Peninsula. South of the north boundary of Township 20 North; after November 15 but not on frozen ground.

ii. Upper Peninsula and Northern Lower Peninsula. North of the north boundary of Township 20 North; after November 1 but not on frozen ground.

c. **Temporary Seeding.** Temporary seed in accordance with the seasonal limitations specified in subsection 816.03.C.4.a.

5. **Inspection.** The Engineer will inspect the seeded turf to ensure that the end result is well established, growing, and vigorous and contains the species required by the seeding mixture.

The Engineer will approve slopes as the Contractor completes permanent restoration on cut slopes, embankment slopes, or portions of slopes. The Engineer will consider each cut or embankment slope on each side of the roadway separately for approval.

Complete weed control in accordance with subsection 816.03.I.

D. **Sodding.** Prepare the topsoil surface, provide and place the sod, and dispose of surplus material. Grade areas required for sodding to Class A slopes in accordance with subsection 205.03.N.

Immediately before laying sod, harrow the topsoil, at least 3 inches deep using a disk, spring tooth drag, spike tooth drag, or other equipment designed to condition the soil. Obtain the Engineer's approval for harrowing equipment. Harrow horizontally across the face of slopes.

Dampen the earth bed before laying the sod. Water the sod immediately after placement, in accordance with subsection 816.03.H. The Engineer will reject sod that has dried out.

Protect sod until placement. Lay sod within 24 hours after cutting. Do not handle sod with pitch forks or dump from vehicles. Do not place frozen sod or place sod on frozen soil. Unless otherwise approved by the Engineer, do not place sod in June, July, or August.

Place sod as shown on the *MDOT Standard Plan R-96* series. Stagger the transverse joints of the sod strips and lay parallel to the flow of water on slopes and in ditches. Place strips with tight joints. Lay sod starting at the base of the slope and work up the slope. Turn edges of sodded areas into the ground and cover with a layer of earth or shoulder material. Compact this material to allow the surface water to flow over the edge of

the sod. Butt the edges of sod firmly against, and level with, paved surfaces.

Work from ladders or treaded planks if necessary to prevent the displacement of sod during sodding operations. Compact sod by tamping immediately after placement. Tamp to a smooth, even surface free of bumps and depressions. Finish the sodded surface to a lawn-like appearance. On slopes steeper than 1:3, use wooden pegs to secure the sod. Space pegs no greater than 2 feet apart and drive flush with the sod surface.

E. **Mulching.** Provide, spread, and anchor mulch material. Place mulch within 1 calendar day after seeding.

Do not mulch during winds that prevent placement and anchoring of the mulch.

Place mulch to allow sunlight to penetrate and air to circulate but thick enough to shade the ground, conserve soil moisture, and prevent or reduce water and wind erosion.

Spread mulch over the surface to a uniform thickness with an application rate of 2 tons per acre. If the Engineer allows dormant seeding, spread the mulch with an application rate of 3 tons per acre. After seed germinates and turf is established, apply herbicide in accordance with subsection 816.03.I.

Maintain the mulched areas and repair areas damaged by erosion, traffic, fire, or other causes before partial or final acceptance. Replace displaced mulch. Repair or replace damaged mulch areas at no additional cost to the Department, unless otherwise provided by subsection 107.11 or section 208.

Replace and anchor mulch that blows away or becomes displaced for reasons attributable to the Contractor, as directed by the Engineer and at no additional cost to the Department.

F. **Mulch Anchoring.** Provide a mulch-anchoring material selected from the Qualified Products List. Spray mulch anchoring immediately after placing mulch. Do not spray if wind prevents the required placement of adhesive. Protect traffic, signs, structures, and other objects from the tackifier material. Immediately remove overspray.

Mix and apply latex base, recycled newsprint, wood fiber, guar gum, and other mulch-tackifier material according to manufacturer’s recommendations or as follows:

1. **Latex-Base.** Mix 15 gallons of adhesive, or the manufacturer's recommended adhesive volume, whichever is greater, with at least 250 pounds of recycled newsprint and 375 gallons of water.
2. **Recycled Newsprint.** Mix 750 pounds of recycled newsprint with 1,500 gallons of water.
3. **Wood Fiber.** Mix 750 pounds of wood fiber with 1,500 gallons of water.
4. **Guar Gum.** Mix 50 pounds of dry adhesive and at least 250 pounds of recycled newsprint with 1,300 gallons of water.
5. **Other Tackifiers.** Mix 150 pounds of dry adhesive, or the manufacturer's recommended adhesive volume, whichever is greater, with at least 250 pounds of recycled newsprint and 1,300 gallons of water.

G. **Mulch Blankets.** Provide, install, and anchor mulch blankets. Provide mulch blankets selected from the Qualified Products List. Place mulch blankets within 1 calendar day after seeding. Secure with net anchors. Place and anchor blankets in accordance with the minimum requirements specified in this subsection or the manufacturer's specifications, whichever is greater.

Overlap blanket edges by 2 inches and shingle lap blanket ends with a 6-inch overlap. Place net anchors along joint edges and blanket centerlines no greater than 2 feet apart. In waterways, shingle lap blankets with an overlap of 12 inches on the downslope edge. Place blankets on backslopes perpendicular to the roadbed. On foreslopes, lay the first strip adjacent to the road, parallel to the road. Lay the remainder of the strips on foreslopes parallel or perpendicular to the road. If installing blankets from the top of the slope, do not allow them to free fall down the slope.

1. **High Velocity Blankets**. Use high-velocity blankets on slopes of 1:2 or steeper and on ditch bottoms, including 12 inches up the front and backslopes.

   The Contractor may substitute high-velocity blankets for mulch blankets at no additional cost to the Department.

2. **Mulch Blankets.** Use mulch blankets on slopes of less than 1:2 next to shoulders and behind curbs. Place mulch blankets with the netting on top and mulch fibers contacting the soil.

   The Contractor may use mulch blankets only on ditch bottoms with ditch gradients no greater than 1.5%.

3. **Turf Reinforcement Mat (TRM)**. Use TRMs for long-term erosion protection and to permanently reinforce vegetation on slopes, ditches, and shorelines.

   Provide the manufacturer's published installation guidelines to the Engineer prior to installation. Install the TRM per the manufacturer's guidelines. Operation of equipment on the slope will not be allowed after placement of the TRM.

H. **Water.** Provide and apply water in accordance with section 911 to sodded and seeded areas at the required rates. The Engineer may adjust watering based on the season and weather conditions.

   1. **Sod**

      a. Water the earth bed with at least 3½ gallons per square yard before laying the sod;

      b. Apply at least 5 gallons per square yard after placing the sod;

      c. Apply an additional 5 gallons per square yard within 24 hours after placing the sod; and

      d. Apply 3½ gallons per square yard of sod, five times at 3- to 5-day intervals.

   2. **Seed**

      a. Water seeded areas at 3½ gallons per square yard or as needed; and

      b. Continue watering regularly after germination begins in order to prevent seeds and seedlings from drying out.

I. **Weed Control.** Provide mowing and/or apply herbicides as directed by the Engineer. Submit the name, label, Material Safety Data Sheets, and application rate of the herbicide to the Engineer and obtain the Engineer's approval before applying.

   To apply herbicides, use a commercial herbicide applicator, licensed in the State of Michigan, and certified by the Michigan Department of Agriculture and Rural Development in the required category. Use application procedures and materials in accordance with federal, state, and local regulations.

   Use equipment that is adequate in size to properly apply the herbicide in a timely manner and that meets federal, state, and local requirements.

   Spray target weeds in the newly seeded turf after the new turf grass is established and will withstand herbicide application.

Target weeds must be eliminated within 14 to 21 days after spraying. Apply additional weed control if the first application does not eliminate all target weeds at no additional cost to the Department. Control target weeds until final acceptance.

Preserve and protect property adjacent to the roadway or work area from injury. Repair damage arising from acts or omissions in the performance of the work at no additional cost to the Department.

J. **Mowing.** Maintain turf at 6 inches or less during construction and until final acceptance. Mowing to be paid for as Weed Control.

K. **Acceptance.** Turf will be accepted when there is sufficient growth across 90% of the restored area to establish the turf bed and prevent soil erosion.

816.04. Measurement and Payment

Pay Item	Pay Unit
Compost Surface, Furn, LM	Cubic Yard
Compost Surface, Furn, __ inch	Square Yard
Topsoil Surface, Salv, LM	Cubic Yard
Topsoil Surface, Salv, __ inch	Square Yard
Topsoil Surface, Furn, LM	Cubic Yard
Topsoil Surface, Furn, __ inch	Square Yard
Fertilizer, Chemical Nutrient, Cl __	Pound
Seeding, Mixture __	Pound
Sodding	Square Yard
Mulch	Square Yard
Mulch Anchoring	Square Yard
Mulch Blanket	Square Yard
Mulch Blanket, High Velocity	Square Yard
Turf Reinforcement Mat	Square Yard
Water, Sodding/Seeding	Unit
Weed Control	Acre

A. **Compost.** The Engineer will measure **Compost Surface, Furn LM** at the source before hauling to the project.

The Engineer will measure **Compost Surface, Furn, __ inch** in place.

B. **Topsoil.** The Engineer will measure **Topsoil Surface, Salv, LM** at the source before placement at the final location.

The Engineer will measure **Topsoil Surface, Salv, __ inch** in place.

The Engineer will measure **Topsoil Surface, Furn, LM** at the source before hauling to the project.

The Engineer will measure **Topsoil Surface, Furn, __ inch** in place.

C. **Fertilizer, Chemical Nutrient.** The Engineer will measure **Fertilizer, Chemical Nutrient, Cl __** of the type required by the weight of nutrient in the fertilizer. The Engineer will determine the weight of chemical fertilizer nutrient for payment using the following formula:

$$T = W \times \sum N \qquad \text{Formula 816-1}$$

Where:

T = Weight of chemical fertilizer nutrients applied;
W = Total fertilizer weight applied; and
N = Percentages of nutrients contained in the fertilizer used.

D. **Sod.** The Engineer will measure **Sodding** in place.

E. **Mulching Material.** The Engineer will measure the following types of **Mulch Blanket** in place:

1. Excelsior mulch blankets;
2. Straw mulch blankets;
3. High-velocity excelsior mulch blanket; and
4. High-velocity straw mulch blanket.

For straw mulch, provide the Engineer with tickets, in triplicate, at the time of delivery, showing the number of bales and weight of each load. Weigh the mulch on scales in accordance with subsections 104.01.F and 109.01.B.6.

The unit price for **Mulch** includes providing and spreading straw mulch at the rate shown on the plans. If the Engineer allows dormant seeding, the Department will pay for mulching it at 1.5 times the unit price for **Mulch**.

The unit price for **Mulch Blanket, High Velocity** includes the cost of providing, placing, and anchoring the blankets.

The unit price for **Mulch Blanket** includes the cost of providing, placing, and anchoring the blankets. If the Contractor substitutes **Mulch Blanket, High Velocity** for **Mulch Blanket**, the Department will pay for the substitution at the unit price for **Mulch Blanket**.

The Engineer will measure **Mulch Anchori**ng in place. The unit price for **Mulch Anchoring** includes the cost of providing and spraying the tackifier.

F. **Turf Reinforcement Mat.** The Engineer will measure **Turf Reinforcement Mat** in place. It includes the cost of providing, placing,

and anchoring mats. Overlapping of material will not be included in the measurement.

G. **Water, Sodding, and Seeding.** The Engineer will measure water for sodding/seeding in units; each unit is equal to 1000 gallons.

H. **Weed Control.** The Engineer will measure and pay for **Weed Control** in place 14 to 21 days after application.

I. **Seeding, Mixture.** The Engineer will measure **Seeding, Mixture** of the type required, in pounds of seed applied.

Section 818. Electrical

818.01. Description

This work consists of providing operating electrical units; removing, salvaging, or disposing of existing electrical components; excavating, backfilling, and restoring the site in accordance with section 816; and disposing of waste excavated materials. Complete this work in accordance with this section, sections 819 and 820, and the contract. For items not specified in section 819 or 820 or the contract, complete the work in accordance with the requirements of the NEC, the NESC, MIOSHA, and the Michigan Department of Licensing and Regulatory Affairs (MDLARA).

Provide personnel who are qualified and experienced in performing the required work. Provide a licensed journeyman electrician supervisor on-site during installation and electrical construction.

818.02. Materials

Provide material in accordance with the following sections:

A. **Conduit**

1. **Direct Burial Application.** Provide a smooth surface conduit of one of the following types for direct burial applications:

   a. Galvanized steel conduit;

   b. Smooth-wall, Schedule 80 rigid (PVC);

   c. Smooth-wall, coilable, Schedule 80 (polyethylene [PE]); or

   d. Rigid fiberglass.

2. Provide Schedule 80 conduit for traffic signal, ITS, and freeway lighting work.

3. **Jacking and Boring Application.** Provide Schedule 80 PVC or Schedule 80 PE conduit for jacking and boring operations.

4. **Directional Boring Application.** Provide Schedule 80 coilable PE conduit for directional boring.

5. **Encased Conduit Application.** Provide Schedule 80 conduit for encased conduit and provide Grade 3500 concrete made with 17A coarse aggregate in accordance with section 1004.

6. **Conduit on Structure Application.** Provide Schedule 80 PVC or rigid fiberglass conduit on structures.

B. **Conductors.** Provide the number of stranded copper conductors for overhead and underground conductors shown on the plans.

C. **Bracket Arm, Clamp On.** This work consists of completing one or more of the following work types at locations shown on the plans:

1. Furnishing and installing a 6-, 9-, 12-, 15-, or 18-foot clamp on bracket arm.

2. Removing and disposing of an existing 6-, 9-, 12-, 15-, or 18-foot clamp on bracket arm.

As applicable, this work includes removal or installation of clamp-on bracket arm of the size specified on the plans and any associated materials required to ensure a complete removal or installation, as specified for a location.

Fabricate the bracket arm truss tubes from 2⅜-inch OD by 0.120-inch-thick steel tubing meeting the requirements of ASTM A500/A500M for Grade B steel and subsection 105.10. Weld to a ⅜-inch-thick steel mounting plate meeting the requirements of ASTM A36/A36M.

Weld ½- by 2-inch flat bar meeting the requirements of ASTM A36/A36M between bracket arm tubes to form the truss. Weld ¼-inch flat bar steel gussets between arm tubes and mounting plate. Complete welding in accordance with AWS D1.1 and the contract.

Hot dip galvanize the bracket arm, all brackets, and hardware after fabrication and welding according to ASTM A123/A123M and ASTM A153/A153M where applicable.

D. **Steel Pole Mount.** Use U-bolts meeting the size requirements below to attach bracket arms to steel poles. Use hex nuts, flat washers, and lock washers to secure U-bolts. U-bolts and hardware must meet the requirements of ASTM A36/A36M steel.

Use ⅝-inch rod U-bolts for pole diameters equal to or greater than 8½ inches but less 9⅛ inches. Use ¾-inch rod U-bolts for pole diameters equal to or greater than 9⅛ inches and equal to or less than 10¼ inches.

E. **Wood Pole Mount**. Fabricate the pole-mounting plate from ⅜-inch-thick steel plate meeting the requirements of ASTM A36/A36M and weld gussets to the arm tubes. There must be one plate per arm tube. Each plate must incorporate two 0.562-inch-diameter holes and one 0.687- by 1.50-inch keyhole for lagging to the wood poles.

818.03. Construction

Contact the MDLARA for electrical service inspection prior to energizing services.

A. **Conduit.** Build straight conduit runs. If the contract requires sweeps, use the largest radius that will fit the work space available for each sweep. Do not install more than 360 degrees of bends per conduit run between junction boxes per NEC.

Provide conduit fittings and use methods of joining conduits, including conduit cement, in accordance with current NEC methods. If the NEC does not clearly describe the method, install the conduits in accordance with the manufacturer's recommendation. Obtain the Engineer’s approval of installation methods before beginning work.

Attach end bells on the ends of conduits entering handholes to prevent damage to the cable.

Install continuous coilable conduit between handholes.

For conduit not terminating in structures such as manholes, handholes, or foundations, extend the conduit 2 feet beyond pavement limit unless otherwise required. Plug unoccupied conduit.

Verify that new conduit inserted into existing manholes or handholes does not interfere with racking, training of cables, or both. Do not disturb existing cables.

1. **Bends.** Bend conduit to the radii specified in the current NEC. For conduit entering foundations or cable pole envelopes, provide conduit with factory bends.

2. **Excavation.** Excavate the conduit trench to provide an earth cover of at least 30 inches over the finished conduit.

3. **Drainage.** Grade the trench to provide drainage to handholes.

4. **Grades.** Stake conduit grades at no greater than 50-foot intervals or as directed by the Engineer. Create a grade that slopes at least 4 inches over 100 feet to the lowest manhole or handhole or from the middle of the conduit run toward both holes.

5. **Backfill.** Tamp the bottom of the trench to produce a smooth, flat, or gently sloping surface before placing the conduit. Backfill trenches outside the roadbed with excavated material, suitable for backfill, as determined by the Engineer. If excavated material is unsuitable, backfill the trenches with Class II granular material in accordance with section 204.

   Backfill trenches within the limits of the roadbed with Class II granular material in accordance with section 204.

6. **Supports.** Provide support for conduit running through holes built over or into existing duct. If ducts are built into an existing handhole, build a 4-inch tapered pocket into the wall. Build new service ducts into existing handholes without interfering with cable racking. Install required inserts.

7. **Clearances.** Do not allow conduit or concrete encasement to contact obstructions. Provide a vertical clearance of 9 inches, except provide at least 12 inches of clearance for conduit running parallel to water lines, gas mains, and other underground structures not part of the electrical system.

   The Engineer and the owner of the obstruction will determine the method of protection if the Contractor cannot provide the required 12-inch clearance.

   Exposed Conduit. For high voltage lines, minimum clearance must follow MIOSHA, NESC, and utility standards.

8. **Clearing.** After installing conduit runs, pull a mandrel 12 inches long, or shorter for conduit runs with bends, and with a diameter ½ inch smaller than the conduit. Attach a swab or cleaning device designed to clear the conduit to the mandrel. Notify the Engineer before performing clearing work.

9. **Encased Conduit.** Encase conduit runs in Grade 3500 concrete. Space adjacent conduits at least 1 inch apart and fill the space with concrete. Provide a conduit encasement with at least 3 inches of concrete around the conduit. If steel reinforcement is required, separate the reinforcing bars from the conduits with 2 inches of concrete. Provide at least 3 inches of concrete cover between the reinforcing bars and the surface of the encasement. Stagger conduit joints vertically.

   Use concrete, plastic, or bituminized fiber as separators, spacers, blocks, or supports that will remain in the finished concrete encasement. If installing 20-foot lengths of conduit, place spacers no

greater than 7 feet apart. If installing 10-foot lengths of conduit, place spacers no greater than 5 feet apart.

Prevent the conduit bank from floating after concrete placement by anchoring the bank to stakes at intervals no greater than 10 feet apart in firm soil and no greater than 5 feet apart in loose soil.

Verify that the concrete fully encases the conduit.

a. **Tier by Tier Method.** Grade the trench and place a foundation of concrete at least 3 inches thick in the bottom of the trench. If steel reinforcement is required, place the concrete at least 5 inches thick with reinforcing bars in place. Lay the bottom tier of conduits, separated by spacers. Fill the space between conduits with concrete and cover the conduits to the height of the next conduit tier. Construct succeeding tiers as specified for the first tier. Provide continuous placement of successive tiers of conduit with interruptions no greater than 45 minutes.

b. **Build-Up or Monolithic Methods**. Grade the trench and place masonry supports at intervals of 3 to 5 feet or a foundation of concrete at least 3 inches thick in the bottom of the trench. If steel reinforcement is required, place the concrete at least 5 inches thick with the reinforcing bars in place. Place the conduit using plastic or concrete separators to erect a rigid, self-supporting structure of conduit. Place the concrete to fill the spaces between the conduits completely, without damaging or displacing them.

   Notify the Engineer prior to encasing the conduit in concrete.

   Place a coupling on the ends of conduit and install a removable plug. Sheet and brace the trenches as required. Support pipes or other structures exposed in the trenches as required to prevent damage.

10. **Directional Bore.** Bore by augering or jacking a steerable rod and pulling back a cone reamer that expands the soil that cuts a hole to the required diameter. Use a reamer with a diameter no greater than 2 inches larger than the conduit, as shown on the plans.

    The Contractor may use a drilling fluid of water and bentonite in directional drilling. The Contractor may use a polymer for lubrication in the drilling fluid.

    Place directional bore or drill equipment and supplies so they do not interfere with traffic or with the use of adjacent property. Locate equipment and supplies a minimum distance from the edge of pavement as directed by the Engineer. Place access pits in the

location of handholes at the boring termination points, as shown on the plans or directed by the Engineer.

11. **Jacking and Boring**

    a. **Compaction Auger (packer, expander).** Auger a rotating stem under the roadway and then pull back a series of graduated cones that displace the soil to obtain the required diameter.

    b. **Hydraulic Push Rods or Stem (pipe puller, packer).** Push rods or stems under the roadway with a hydraulic ram and pull a series of graduated cones that displace the soil to obtain the required diameter.

    c. **Other Methods.** The Engineer may approve other jacking and boring methods before construction. Do not jet or use water or air ahead of the casing.

       The Contractor may use air rams longitudinally in the right-of-way but under roadways only if approved by the Engineer.

       Before jacking and boring, excavate a starter alignment trench to the elevation of the proposed conduit. Excavate a length of level trench at least 15 feet long for trenches up to 4 feet deep, and increase the trench length 5 feet for each additional 1 foot of depth.

       Use guide rails, sills, or other positive alignment devices to start the crossing. Restrain drive rods against horizontal and vertical movement.

       If using heads to develop an opening with a diameter greater than 2 inches, develop openings by increasing the head size in 1 inch increments.

       If the highway is super-elevated, start the bore from the lower side of the pavement.

       The Engineer will determine whether conditions warrant the use of sheeting and bracing. Use sheeting and bracing for boring as directed by the Engineer if access pits are located within the 1:1 slope from the edge of paved surfaces or back of curbs.

       Place access pits in the location of handholes at the boring termination points, as shown on the plans or directed by the Engineer.

       Provide the bore and jack record sheet or log if requested by the Engineer.

Control groundwater entering the excavation from seepage layers and lenses or pockets of saturated material from inside the excavation using drainage, bailing, pumping, or other methods. Do not remove or disturb adjacent soil while draining the groundwater.

If ordinary methods of drainage prove unsatisfactory, as determined by the Engineer, drain excavations as required.

12. **Record Drawings.** Within 5 days after completing conduit work or installing working cables, provide a record drawing to the Engineer. Show deviations from the original plans. Measure the lengths from the inside walls of the handholes and the center of post foundations and cable poles.

B. **Electrical Wire and Cable**

Permanently tag wires and cables in manholes, handholes, and cabinets at the points of entrance, exit, splicing, and termination. Label new and affected wires and cables to indicate the source and use of each where above grade. Tag wires and cables in manholes and handholes with a stamped brass tag.

Provide wires and cables with an additional length of at least 10 feet in each manhole and handhole.

Seal cable ends where the plans show coiling of cable.

Cut and remove cables within handholes and manholes for abandoned underground cables as shown on the plans.

Permanently label detector wiring harnesses at the cabinet terminal strip with the source and use.

Do not install service entrance conductors in handholes or vaults containing other wires or cables.

Do not splice signal cables or interconnect cables for traffic signals unless indicated in the plans.

C. **Direct Burial Conductors.** Provide and install direct burial single conductors.

1. **Approval.** Unless otherwise specified in the contract, the Department is the agency responsible for maintaining direct burial conductor facilities. Provide certified test reports to the maintaining agency upon request.

2. **Installation.** Install direct burial conductors as shown on the plans and in accordance with the manufacturer’s recommendations. Do not drag conductors on the ground. Do not splice conductors

underground. Install conductors in continuous runs between manholes, handholes, or foundations.

3. **Location.** Install direct burial conductors parallel to the edge of pavement, along the shoulder edge, clear of guardrail locations. Place conductors in a straight line between visible reference points such as handholes or light standards.

4. **Excavation.** After compacting the subbase in the shoulder area to at least the elevation of the top of the base course, cut a trench along the shoulder edge for placement of the conductors.

   Remove rocks or other sharp objects from the trench. Lay the conductors in the trench.

   Install marking tape from 6 to 18 inches above underground conduit or cable. Do not install marking tape above jacked and bored conduit. The Department will provide the marking tape.

   Provide 3 feet of cover over direct burial cable installed outside the shoulder.

5. **Conductors Installed In Conduit.** If installing direct burial conductors in conduit, use clean conduit, free of rough spots.

   Avoid damage to insulation and conductor jackets during installation.

   When required, use lubricating compounds approved by the conductor manufacturer. Use non-injurious lubricants listed by nationally recognized testing laboratories on conduits, conductors, insulations, or jackets.

   Provide slack in each run of cable.

   Group multiple conductors trained through a box, manhole, or handhole, by circuit. Bundle them using cable ties, and support them to reduce pressure or strain on conductor insulation. Bend wire and cable in accordance with the manufacturer's recommended bending radius during installation and in permanent placement.

   Use a cable-pulling apparatus with no sharp edges or protrusions.

6. **Testing.** Test direct burial conductors for continuity, shorts, and grounds after installation and backfill. Replace conductors that fail field tests with new conductors at no additional cost to the Department.

D. **Equipment Grounding and Bonding.** Provide and install grounding electrode conductors to provide a continuous grounding electrode system. Install grounding electrode conductors and connect to light standard bases, strain poles, pedestal bases, span wires, concrete-encased

electrodes, ground rods, and service disconnects. For traffic signals, all equipment listed above that is associated with a single cabinet must be bonded to a continuous connection from grounding electrode system. Do not use equipment grounding conductors to provide continuity of the grounding electrode system. Install equipment grounding conductors in the same raceway or trench as the current-carrying conductors and connect to the ground bus at the electrical source and to the grounding termination at the utilization equipment.

If installing conductors directly in earth with no conduit protection, the Contractor may use a bare conductor. Install the conductor at the same depth as a conductor installed in conduit.

If installing the conductors in conduit, use an insulated conductor, color-coded green in accordance with subsection 918.04.A. Do not damage the conductor during installation.

E. **Handholes**. Provide and install, remove, salvage, reconstruct, abandon, or adjust handholes, including covers and fittings as shown on the plans.

If the plans show existing cables maintained in new handholes, break and remove conduit and concrete encasements to the walls of the new handhole. Extend existing cables, train, rack, and support on the walls of the handhole.

1. **Remove or Abandon.** Remove handholes completely or abandon in accordance with section 204.
2. **Adjust.** Adjust handholes in accordance with section 403.
3. **Reconstruct.** Reconstruct handholes in accordance with section 403. Use existing frames and covers unless otherwise directed by the Engineer.
4. **Installation**. Ensure that handholes are flush with the pavement surface and 1 inch above grade outside paved areas. Install the frame and cover flush with the top of the handhole.

   Use CIP or precast reinforced concrete handholes.

   Make the inner surface of reinforced handholes smooth. Sandblast castings. Cast handholes free of pouring faults, blow holes, cracks, and other imperfections. Cast handholes that are sound, true to form and thickness, clean, and finished.

   Provide and install cable racks and hooks.

   Plug unused conduit entrances and conduit openings for future use by others with removable plastic plugs or other plugs approved by the Engineer.

Remove rubbish, construction debris, and water from handholes. Grout conduits from outside the handholes to inside the handholes.

5. **Excavation.** Excavate to the diameter and depth for installing handholes at locations shown on the plans.

6. **Drainage.** Cast drain holes at the bottom of the handhole. Provide drainage of handholes installed over underground conduits and on bridge decks.

7. **Backfill.** Install the handhole on Class II granular material. The Engineer will determine whether excavated material meets the backfill requirement. Use Class II granular material if the Engineer determines that excavated material does not meet the backfill requirement.

F. **Electrical Service Requirements**

1. **Unmetered Service.** Provide NEMA type 4X service disconnecting means with stainless steel enclosures, unless otherwise required. The Department will provide means for padlocking the operating handles in the open or closed position. If directed by the Engineer, run conduit on the outside of the pole. Support the conduit using two-hole galvanized support brackets, spaced no greater than 3 feet apart. Bond the conduits and equipment as required by the NEC, utility company, and the contract. Use waterproof metal elbows with removable covers to enter and exit service disconnects and controllers.

2. **Metered Service**. Provide NEMA type 4X service disconnecting means with stainless steel enclosures, unless otherwise required. The Department will provide means for padlocking the operating handles in the open or closed position. On wood poles, connect the meter socket to the service disconnect using at least 1½-inch-diameter Schedule 80 PVC or galvanized metal conduit. On steel poles, connect the wiring between the meter socket and the service disconnect on the inside of the pole. If directed by the Engineer, run conduit on the outside of the pole. Support the conduit using two-hole galvanized support brackets, spaced no greater than 3 feet apart. Bond the conduits and equipment as required by the NEC, utility company, and the contract. Use waterproof metal elbows with removable covers to enter and exit meters, service disconnects, and controllers.

3. **Electrical Service Removals**. Contact the local power company shown on the plans to coordinate removal of metered service and power feed. Perform removal work in accordance with the NEC, the contract, and the local power company standards.

G. **Wood Pole.** Provide and install, relocate, or remove wood poles and associated hardware for supporting span wire and bracket-arm-mounted traffic signals, and guying the pole per span.

Tamp the earth replaced around new or relocated poles. Fill, tamp, and level holes after removing poles. Use hot dip galvanized turnbuckles, tension tie bars, and associated steel hardware in accordance with ASTM A153/A153M.

Set wood poles to the minimum depths specified in Table 818-1:

Table 818-1:
Wood Pole Lengths and Depths

Pole Length	Depth
35-foot Class 4 pole	6 feet
40-foot Class 4 pole	6 feet
45-foot Class 4 pole	6½ feet
50-foot Class 4 pole	7 feet
55-foot Class 4 pole	7½ feet
60-foot Class 4 pole	8 feet

818.04. Measurement and Payment

Pay applicable fees for electrical service inspection per MDLARA.

Pay Item	Pay Unit
Conduit, Rem	Foot
Conduit, Encased, (number), __ inch	Foot
Conduit, Directional Bore, (number), __ inch	Foot
Conduit, DB, (number), __ inch	Foot
Conduit, (type), __ inch, Structure	Foot
Conduit, (type), __ inch	Foot
Conduit, Schedule (number), __ inch	Foot
Conduit, Jacked Bored, (number), __ inch	Foot
DB Cable, 600V, 1/C# (size)	Foot
DB Cable, in Conduit, 600V, 1/C# (size)	Foot
DB Cable, in Conduit, Rem	Foot
Cable, Rem	Foot
Cable, (type), Rem	Foot
Cable Pole, (type), Disman	Each
Cable, P.J., 600V, 1, (size)	Foot
Cable, Sec, (volt), (number), (size)	Foot
Cable, Sec, (type), (number), (size)	Foot
Cable, Shielded, (volt), (number), (size), (type)	Foot
Cable, St Ltg, (volt), (number), (size), (type)	Foot

Cable, Equipment Grounding Wire, 1/C# (size) ..... Foot
Bracket Arm, Clamp On, _Foot, with _ Foot Rise ..... Each
Bracket Arm, Clamp On, Rem ..... Each
Hh, (type) ..... Each
Hh, (type), (size) ..... Each
Hh, (work) ..... Each
Metered Serv ..... Each
Metered Serv, Rem ..... Each
Unmetered Serv ..... Each
Unmetered Serv, Rem ..... Each
Wood Pole ..... Each
Wood Pole, Cl __, __ foot ..... Each
Wood Pole, Rem ..... Each
Serv Disconnect ..... Each
Serv Disconnect, Rem ..... Each
Serv Disconnect, Salv ..... Each
Wood Pole, Fit Up, (type) ..... Each
Conc Pole, Fit Up, (type) ..... Each
Steel Pole, Fit Up, (type) ..... Each

Unless otherwise required, the unit prices for the pay items listed in this subsection include the cost of excavation, granular material, backfill, and disposal of waste excavated material. Restoring the site in kind in accordance with section 816 will be paid for separately.

A. **Conduit.** The Engineer will measure conduit in place, from the inside walls of manholes, and the centers of handholes, post foundations, and cable poles.

The unit prices for **Conduit, Rem** include the cost of removing the type, number, and size of conduit shown on the plans.

The unit prices for **Conduit, (type), __ inch** and **Conduit, DB, (number), __ inch** include the cost of installing the type, number, and size of conduit shown on the plans, and installing marking tape.

The unit price for **Conduit, (type), __ inch, Structure** includes the cost of providing and installing the conduit components, hardware, and other appurtenances required.

The unit price for **Conduit, Jacked Bored, (number), __ inch** includes the cost of installing rigid metal, or Schedule 80 PVC conduit.

The unit price for **Conduit, Directional Bore, (number), __ inch** includes the cost of installing Schedule 80 PE conduit.

The unit price for **Conduit, Encased, (number), __ inch** includes the cost of the following:

1. Installing conduits;
2. Installing sheeting and bracing;
3. Removing boring pits; and
4. Filling voids.

The unit price for **Conduit, Schedule (number), __ inch** includes the cost of installing conduit approved for direct burial applications, as specified in subsection 818.02.A.1, and installing marking tape.

B. **Direct Burial Cable.** The Engineer will measure cables in place for the total length of the required conductors, single, multiple, or both.

The Engineer will measure direct burial cable, at grade, between centers of handholes, light standards, and poles.

The Engineer will not measure the following cable portions:

1. Looping;
2. Sag;
3. Trainers;
4. Splicing;
5. Racking;
6. Slack length; or
7. Length inside equipment.

The Engineer will measure the vertical length of cable from 2½ feet below grade to the pot head or service head at cable poles.

The unit prices for the relevant direct bury cable pay items include the cost of marking tape, bonding, tagging, and making splices, terminations, and connections.

The unit price for **DB Cable, in Conduit, 600 Volt, 1/C# (size)** includes the cost of pulling the cable in the conduit.

The unit price for **DB Cable, in Conduit, Rem** includes the cost of removing all cables from the existing conduit measured per lineal foot of conduit.

C. **Cable, Removal.** The unit prices for **Cable, Rem** and **Cable, (type), Rem** include the cost of dead ending, circuit cutting, work required to leave circuits operable, and disposing of the removed cables, wire, hardware, and other appurtenances.

The unit prices for other items of work include the cost of abandoning cables and conduit.

D. **Cable, Pole Dismantle.** The unit price for **Cable, Pole, (type), Disman** includes the cost of dismantling and off-site disposal of the following:

1. Riser pipe;
2. Cross arms;
3. Lightning arrestors;
4. Pot heads;
5. Cutouts;
6. Molding;
7. Weather cap;
8. Concrete encased bend; and
9. Other related materials.

E. **Cable, P.J.; Cable, Section; Cable, Shielded, and Cable, Street Lighting.** The Engineer will measure **Cable, P.J., Cable, Sec, Cable Shielded**, and **Cable, St Ltg**, of the type required, including the number and size of conductors, in place from centers of manholes or handholes and between wood poles, and will add 10 feet of cable for every handhole.

The unit prices for **Cable, P.J., Cable, Sec, Cable Shielded**, and **Cable, St Ltg**, of the type required, include the cost of the following:

1. Racking in manholes and handholes;
2. Bonding and tagging cables in manhole and handhole identifications;
3. Making splices and connections;
4. Cutting cable and re-splicing for service to traffic signals; and
5. Providing and installing the cable components, hardware, and other appurtenances required.

F. **Cable, Equipment Grounding Wire.** The Engineer will measure **Cable, Equipment Grounding Wire, 1/C# (size)** in a straight line between changes in direction and to the centers of light standards and the control cabinet. The Engineer will measure only one equipment grounding conductor if more than one circuit conductor run is installed in conduit.

The unit price for **Cable, Equipment Grounding Wire, 1/C# (size)** includes the cost of the following:

1. Installing grounding conductor in conduit;
2. Vertical conductors and required slack;
3. Bonding;
4. Tagging; and
5. Making splices and connections.

For traffic signals, the Department considers equipment grounding incidental to electrical work and will not pay for it separately.

G. **Electrical Service, Removal.** The unit price for **Elec Serv, Rem** includes the cost of returning the meter to the local utility company and disposing of the removed concrete-encased conduit, cables, hardware, and other appurtenances.

H. **Handholes (Hh).** The unit prices for handhole pay items include the cost of removing concrete encasement and conduit where new manholes or handholes access an existing conduit run as indicated on the plans and installing cable racks and hooks.

The Department differentiates between **Hh, (type)** and **Hh, (type), (size)** based on the size and type of material to construct the handhole.

The unit prices for **Hh, (type)** and **Hh, (type), (size)** include the cost of the frame and cover, ground rods, and treated wood foundations.

The Department will differentiate **Hh, (work)** pay items by the activities required to complete the work. The following pay items are **Hh, (work)** pay items:

1. **Handhole Adjust.** The unit price for **Hh, Adj** includes the cost of using existing frames and covers.
2. **Handhole Abandon.** The Engineer will measure **Hh, Abandon** by planned quantities. The unit price for **Hh, Abandon** includes the cost of removing the frame and cover and breaking down the wall structure.

   The unit price for **Hh, Access** includes the cost of installing the following:

   a. Access handhole openings and covers in existing steel poles;
   b. Additional hardware;
   c. Reinforcing frames;

d. Stainless steel screws; and

e. Other material required to complete the work.

3. **Handhole Reconstruct, Remove, and Salvage**. The unit price for **Hh, Reconst** includes the cost of using existing frames and covers.

   The unit price for **Hh, Rem** includes the cost of removing the handhole.

   The unit price for **Hh, Salvage** includes the cost of installing salvaged handholes.

I. **Service Disconnect.** The unit prices for installing, salvaging as required, and removing the relevant service disconnect pay items include the cost of the service disconnect (salvaged as required), fuses, brackets, hardware, cable, conduit, grounding (wire and ground rods), and other material required to complete the work.

   The unit price for **Serv Disconnect, Rem** includes the cost of removing the disconnect, connectors, wiring, grounding, and ground rods and any other material required to complete the work.

   The unit price for **Serv Disconnect, Salv** includes the cost of installing the salvaged service disconnect, including all other material required to complete the work.

J. **Metered Service.** The unit prices for installing the relevant **Metered Serv** include the cost of material required by the local utility company and the NEC and providing and installing the meter, meter sockets, brackets, hardware, equipment supporting structure, cable, conduit, grounding, and other material required to complete the work.

   The unit price for **Metered Serv** includes the cost of returning the meter to the local utility company, storage, or disposal of removed material and all other material required to complete the work.

   The unit price for **Metered Serv, Rem** includes the cost of removing the meter and meter socket and all other material required to complete the work.

K. **Unmetered Service.** The unit prices for **Unmetered Serv** and **Unmetered Serv, Rem** include the cost of material and labor required to install and remove, in accordance with NEC, the relevant unmetered service items. Providing and installing all brackets, hardware, equipment supporting structure, cable and/or wire, conduit, conduit fittings, and grounding are also considered included in the unit price.

   The lump sum pay item, **Power Co. (Est. Cost to Contractor)**, includes the cost of reimbursing the Contractor for payments made to the power

company for providing electrical power at the locations shown on the plans. The Department will estimate the reimbursement costs to the Contractor and establish a lump sum price as shown on the plans. The Engineer will measure and the Department will pay the Contractor for power company invoices paid, as submitted to the Engineer.

The Contractor is responsible for scheduling and coordinating installation and payment with the Engineer.

The unit prices for the relevant pay items include the cost of installing and other appurtenances required.

L. **Wood Pole.** The unit price for **Wood Pole** includes the cost of providing and installing pole markers, additional support, components, hardware, and other required appurtenances and transferring wires from old to new poles.

The unit price for **Wood Pole, Cl __, __ foot** includes the cost of guying wood poles of the required class.

The Engineer will measure **Wood Pole, Rem** based on plan quantities in accordance with subsection 109.01.

The unit price for **Wood Pole, Rem** includes the cost of removing and storing, if required, poles, concrete, pole bases, and hardware.

The unit price for **Wood Pole, Fit Up** includes the cost of arranging wire on poles and providing and installing the components, wires, hardware, and other required appurtenances.

M. **Concrete Pole, Fit Up.** The unit price for **Concrete Pole, Fit Up** includes the cost of providing and installing the conduit, hardware, and other appurtenances required.

N. **Steel Pole, Fit Up.** The unit price for **Steel Pole, Fit Up** includes the cost of providing and installing the conduit, hardware, and other required appurtenances.

O. **Bracket Arm.** The unit price for **Bracket Arm, Clamp On, _Foot, with _ Foot Rise** includes all labor, equipment, and materials required to install a clamp-on bracket arm of the type specified including, hardware, fittings, connectors, ground wire, grounding, and other such material required to provide a complete bracket arm installation.

Bracket Arm, Clamp On, Rem includes all labor and equipment required to remove the bracket, hardware, and appurtenant items as required for a complete removal. **Bracket Arm, Clamp On, Rem** includes storage and disposal of removed materials.

Section 901. Cement and Lime

901.01. General Requirements

Provide facilities for sampling and inspecting cement at the mill, distribution point, and project. Store cement to allow access for inspection and identification of each shipment.

Ensure that Portland cement does not develop false set if tested by the mortar method specified in ASTM C359. The Department defines false set as occurring if penetration is less than 5 mm at 5-, 8-, or 11-minute intervals. The Department will apply these limits if difficulties arise from premature stiffening during the concrete placement or finishing.

Before concrete placement, provide the Engineer a copy of the Certification of Quality of Cement, as provided by the producer.

901.02. Testing

Cement and lime materials testing must be in accordance with the specified ASTM, AASHTO, or Department methods, as modified by this section.

901.03. Portland Cement

A. **Type I, Type II, and Type III Portland Cements.** Type I, Type II, and Type III Portland cements must meet the requirements of ASTM C150/C150M. The requirements for time of setting by Gillmore Needle or Vicat Needle and the 7-day and 28-day compressive strength apply.

B. **Blended Cements.** Blended cements must meet the requirements of ASTM C595/C595M.

901.04. Masonry Cement

Masonry cement must meet the requirements of ASTM C91/C91M, Type N, Type S, or Type M.

901.05. Hydrated Lime

Hydrated lime must meet the requirements of ASTM C207, Type S, or Type SA.

901.06. Slag Cement

Slag cement must meet the requirements of ASTM C989/C989M, Grade 100, minimum.

901.07. Fly Ash

Fly ash must meet the requirements of ASTM C618, Class F or Class C, except that the loss on ignition must not exceed 5% and the air-entraining admixture uniformity requirement in ASTM C168, Table 3 of Supplementary Optional Physical Requirements, applies.

901.08. Silica Fume, Dry-Densified

Dry-densified silica fume must meet the requirements of ASTM C1240.

Section 902. Aggregates

902.01. General Requirements

The Department may re-inspect and retest aggregates regardless of inspection at the producing plant. Provide safe access to the material for sampling from haul units or stockpiles.

Do not use spent metal casting foundry sand unless the contract expressly allows for its use.

Do not contaminate aggregate during loading or measurement.

902.02. Testing

Test aggregate materials in accordance with the following:

Material	Test
Wire Cloth and Sieves	AASHTO M92
Materials Finer than 75 mm (No. 200) Sieve in Mineral Aggregates by Washing	AASHTO T11
Specific Gravity and Absorption of Coarse Aggregate	AASHTO T85
Specific Gravity and Absorption of Fine Aggregates	AASHTO T84
Sieve Analysis of Fine and Coarse Aggregate	AASHTO T27
Sampling and Testing Fly Ash	ASTM C311/C311M
Organic Impurities in Fine Aggregate	AASHTO T21
Sieve Analysis of Mineral Filler	AASHTO T37
Mortar Strength	AASHTO T71
Particle Size Analysis	AASHTO T88
Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test	AASHTO T176
Uncompacted Void Content of Fine Aggregate	AASHTO T304
Sand Equivalent of Fine Aggregate	ASTM D2419
Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate	ASTM D4791
Water Asphalt Preferential Test	MTM 101
Los Angeles (LA) Abrasion Resistance of Aggregate	MTM 102
Insoluble Residue in Carbonate Aggregate	MTM 103

A. **Definitions.** The Department uses the following terminology in the testing and acceptance of aggregates:

Base Fineness Modulus. Average fineness modulus typical of the source for a specific fine aggregate.

Cobblestones (Cobbles). Rock fragments, usually rounded or semi-rounded, with an average dimension between 3 and 10 inches.

Crushed Concrete Aggregate. Crushed Portland cement concrete.

Crushed Particles. Particles with at least one fractured face. The contract will specify the number of fractured faces based on required use. Unless otherwise specified, one fractured face is considered a crushed particle.

Iron Blast Furnace Slag. Synthetic nonmetallic byproduct simultaneously produced with pig iron in a blast furnace that consists primarily of a fused mixture of oxides of silica, alumina, calcium, and magnesia.

Manufactured Fine Aggregate. 100% crushed rock, gravel, iron blast-furnace slag, reverberatory furnace slag, or steel furnace slag.

Natural Aggregates. Aggregates that originated from stone quarries, gravel, sand, or igneous/metamorphic rock deposits.

Natural Sand 2NS and 2MS. Fine, clean, hard, durable, uncoated particles of sand free of clay lumps and soft or flaky granular material resulting from the natural disintegration of rock and used in concrete mixtures, mortar mixtures, and intrusion grout for pre-placed aggregate concrete.

Relative Density (oven dry [OD]). Specific gravity of aggregate that is dried or assumed to be dried. The aggregate is considered dried when it has been maintained at a temperature of 110 ± 5°C for sufficient time to remove all combined water by reaching a constant mass.

Reverberatory Furnace Slag. Nonmetallic byproduct of refined copper ore.

Salvaged Aggregate. Dense-graded aggregate or open-graded aggregate saved or manufactured from Department project sources that may consist of natural aggregate or blast furnace slag with particle sizes no greater than 2 inches and no visible organic or foreign matter.

Slag Aggregates. Byproducts formed in the production of iron, copper, and steel.

Soft Particles. Structurally weak particles or particles experiencing environmental deterioration, including shale, siltstone, friable sandstone, ochre, coal, and clay ironstone.

Steel Furnace Slag. Synthetic byproduct of basic oxygen, electric, or open-hearth steel furnaces that consist primarily of a fused mixture of oxides of calcium, silica, iron, alumina, and magnesia.

Stone Sand 2SS. Sand manufactured from stone sources. The sources must meet the physical requirements for coarse aggregate 6A prior to crushing. Stone sand in concrete base course or structural concrete is allowed only if not exposed to vehicular traffic.

902.03. Coarse Aggregates for Portland Cement Concrete

For coarse aggregates for Portland cement concrete, use Michigan Class 6AAA, 6AA, 6A, 17A, and 26A coarse aggregate produced from natural aggregate, iron blast furnace slag, or reverberatory furnace slag sources.

The Contractor may produce Michigan Class 6A, 17A, and 26A from crushed Portland cement concrete for uses specified in this subsection.

Ensure that the relative density (OD) falls within the limits established by freeze-thaw testing.

Provide coarse aggregates for Portland cement concrete in accordance with Table 902-1, Table 902-2, and this subsection.

A. **Slag Coarse Aggregate.** Use slag coarse aggregate consisting of iron blast furnace slag or reverberatory furnace slag with a dry (loose measure) unit weight of at least 70 pounds per cubic foot in accordance with MTM 123.

B. **Crushed Concrete Coarse Aggregate.** Use Department-owned concrete on the project to produce crushed concrete coarse aggregate. The Contractor may use crushed concrete coarse aggregate in the following concrete mixtures: curb and gutter, valley gutter, sidewalk, concrete barriers, driveways, temporary pavement, interchange ramps with a commercial average daily traffic (ADT) of less than 250, and concrete shoulders.

   Do not use crushed concrete coarse aggregate in the following: mainline pavements or ramps with a commercial ADT greater than or equal to 250, concrete base course, bridges, box or slab culverts, headwalls, retaining walls, pre-stressed concrete, or other heavily reinforced concrete.

   Avoid contamination with non-concrete materials, including joint sealants, hot mix asphalt (HMA) patching, and base layer aggregate or soil, when processing crushed concrete coarse aggregate. Limit contamination particles retained on the ⅜-inch sieve to no greater than 3.0%, based on a particle count of the total retained ⅜-inch aggregate particles. Aggregate stockpile contaminated with building brick, wood, or plaster will be rejected. Steel reinforcement pieces may remain in the stockpile if they can pass the maximum grading sieve size without aid. Ensure that the fine aggregate portion of the gradation does not exceed a liquid limit of 25.0% or a plasticity index of 4.0.

   The Engineer will test the freeze-thaw durability of crushed concrete coarse aggregate for each project. After the Department's central laboratory receives the aggregate samples from the supplier, each test will require at least 3 months.

   Crush concrete ensuring that it maintains uniform aggregate properties with no apparent segregation. The relative density (OD) must not vary more than ±0.05 and absorption by more than ±0.40. Separate crushed concrete aggregate according to the original coarse aggregate type, except in the following situations:

1. If the weighed quantities of each aggregate type retained on the No. 4 sieve do not differ from the average quantities obtained from at least three representative samples by more than 10%; or

2. If using aggregate produced from concrete pavement with only one type of aggregate but repaired with concrete patches with a different aggregate type.

C. **Aggregates for Optimized Gradation**

1. **Coarse Aggregate Requirements**

a. Coarse aggregate includes all aggregate particles greater than or retained on the $^{3}/_{4}$-inch sieve.

b. The physical requirements for the coarse aggregate are as specified in Table 902-1 and as follows:

i. High-performance concrete mixtures – Class 6AAA; and

ii. All other concrete mixtures requiring optimized gradation – Class 6AA.

c. The maximum loss by washing (LBW) per MTM 108 is 2.0% for materials produced entirely by crushing rock, boulders, cobbles, slag or concrete; otherwise 1.0%.

d. The maximum 24-hour soak absorption is 2.50%.

2. **Intermediate Aggregate Requirements**

a. Intermediate aggregate includes all aggregate particles passing the $^{3}/_{4}$-inch sieve through those retained on the No. 4 sieve.

b. The physical requirements for intermediate aggregate are as specified in Table 902-1 for Class 26A.

c. The maximum LBW per MTM 108 is 3.0%.

3. **Fine Aggregate Requirements**

a. Fine aggregate includes all aggregates particles passing the No. 4 sieve.

b. The fine aggregate must meet the requirements of subsection 902.08.

902.04. Chip Seal Aggregates

For single chip seal, use 34CS aggregate with a maximum moisture content in accordance with Table 902-8 and as described in MDOT's *Procedures for*

Aggregate Inspection, calculated in accordance with section 109 at the time of placement, and in accordance with Table 902-7 and Table 902-8.

For double chip seal, use CS-T aggregate with a maximum moisture content in accordance with Table 902-8 and as described in MDOT's *Procedures for Aggregate Inspection*, calculated in accordance with section 109 at the time of placement, and in accordance with Table 902-7 and Table 902-8.

902.05. Dense-Graded Aggregates for Base Course, Surface Course, Shoulders, Approaches, and Patching

When necessary, combine fine aggregate with natural aggregate, iron blast-furnace slag, reverberatory furnace slag, or crushed concrete to produce Michigan Class 21AA, 21A, 22A, 23A, and 23AA dense-graded aggregates in accordance with Table 902-1, Table 902-2, and this subsection.

The use of crushed concrete is prohibited on the project within 100 feet of any water course (stream, river, county drain, etc.) and lake regardless of the application or location of the water course or lake relative to the project limits.

Dense-graded aggregate produced by crushing Portland cement concrete must not contain more than 5.0% building rubble or HMA by particle count. The Department defines building rubble as building brick, wood, plaster, or other material. Pieces of steel reinforcement capable of passing through the maximum grading sieve size without aid are allowed.

Do not use Class 21AA, 21A, or 22A dense-graded aggregate produced by crushing Portland cement concrete to construct an aggregate base or an aggregate separation layer when the dense-graded layer drains into an underdrain unless at least one of the following conditions apply:

A. A vertical layer of at least 12 inches of granular Class I, II, IIA, or IIAA exists between the dense-graded aggregate layer and an underdrain; or

B. A geotextile liner or blocking membrane that will be a barrier to leachate is placed between the crushed concrete and the underdrain.

Produce Class 23A dense-graded aggregate from steel furnace slag for use only as an unbound aggregate surface course or an unbound aggregate shoulder.

902.06. Open-Graded Aggregates for Earthwork, Open-Graded Drainage Courses, and Underdrains

Use Michigan Class 4G, 34G, 34R, and 46G open-graded aggregates produced from natural aggregate, iron blast-furnace slag, or reverberatory furnace slag in accordance with Table 902-1 and Table 902-2. Class 4G may be produced from crushed concrete.

The use of crushed concrete is prohibited on the project within 100 feet of any water course (stream, river, county drain, etc.) and lake regardless of the application or location of the water course or lake relative to the project limits.

Open-graded aggregate 4G produced by crushing Portland cement concrete must not contain more than 5.0% building rubble or HMA by particle count. The Department defines building rubble as building brick, wood, plaster, or other material. Pieces of steel reinforcement capable of passing through the maximum grading sieve size without aid are allowed.

902.07. Granular Materials for Fill and Subbase

Use granular materials consisting of sand, gravel, crushed stone, iron blast-furnace slag, reverberatory furnace slag, or a blend of aggregates in accordance with Table 902-3 and this subsection.

The Contractor may make the following substitutions:

A. Class I, Class IIAA, or Dense-Graded Aggregate 21A, 21AA, or 22A material for Class II material;

B. Class I, Class II, Class IIA, Class IIAA, Class IIIA, or Dense-Graded Aggregate 21A, 21AA, or 22A material for Class III material;

C. Class I material for Class IIAA material; and

D. Dense-Graded Aggregate 21A, 21AA, or 22A material for Class IIA.

Do not use material with cementitious properties or with permeability characteristics that do not meet design parameters for subbase.

Granular material produced from crushed Portland cement concrete is not permitted.

The Engineer may allow the placement of granular material produced from steel furnace slag below the top 3 feet of the embankment and fill.

902.08. Fine Aggregates for Portland Cement Concrete and Mortar

Test for organic impurities in accordance with AASHTO T21. The aggregate must not produce a color darker than Organic Plate No. 3 (Gardener Color Standard No. 11). The Engineer may approve the use of fine aggregate that fails the test for organic impurities based on one of the following:

A. The discoloration resulted from small quantities of coal, lignite, or similar discrete particles, or

B. The tested concrete develops a relative 7-day strength of at least 95% in accordance with AASHTO T71.

Uniformly grade the aggregate from coarse to fine in accordance with Table 902-4. Fine aggregate 2NS, 2SS, and 2MS must meet fineness modulus requirements in Table 902-4.

Do not use crushed Portland cement concrete fine aggregate in concrete mixtures.

902.09. Aggregate General Requirements for HMA Mixtures

Use aggregate materials meeting the requirements of Table 902-5 and Table 902-6 for the HMA mix number and type required, respectively.

A. **Coarse Aggregates.** For HMA mixtures, use natural aggregate, iron blast-furnace slag, reverberatory furnace slag, steel furnace slag, or crushed concrete as coarse aggregate.

B. **Fine Aggregates.** For HMA mixtures, use natural aggregate, iron blast-furnace slag, reverberatory furnace slag, steel furnace slag, manufactured fine aggregate, or a uniformly graded blend as fine aggregate. Fine aggregates must be clean, hard, durable, uncoated, and free of clay lumps, organic matter, soft or flakey material, and other foreign matter.

902.10. Surface Treatment Aggregates

A. **Paver-Placed Surface Seal.** For paver-placed surface seal, use aggregate 27SS or 30SS consisting of material meeting the requirements in subsection 902.09.B and in accordance with Table 902-7 and Table 902-8.

B. **Micro-Surfacing.** For micro surfacing, use 2FA and 3FA aggregates consisting of crushed material from a quarried stone, natural gravel, slag source, or a blend in accordance with Table 902-7 and Table 902-8.

C. **Slurry Seal.** For slurry seal, use 2FA aggregate consisting of crushed material from a quarried stone, natural gravel, slag source, or a blend in accordance with Table 902-7 and Table 902-8.

902.11. Mineral Filler for HMA Mixtures

For HMA mixtures, use dry, 3MF mineral filler consisting of limestone dust, dolomite dust, fly ash collected by an electrostatic precipitation method, slag, or hydrated lime with 100% passing the No. 30 sieve and 75% to 100% passing the No. 200 sieve. Mineral filler must be from a Department-approved source or must be tested on a per-project basis. The free carbon content of the fly ash sample must not exceed 12% by weight as measured by the loss on ignition test in accordance with ASTM C311/C311M.

Table 902-1:
Grading Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open-Graded Aggregates

Material Type	Series/ Class	Item of Work by Section Number (Sequential)	Sieve Analysis (MTM 109) Total % Passing[a]										LBW (MTM 108) % Passing
			2½ inch	2 inch	1½ inch	1 inch	¾ inch	½ inch	⅜ inch	No. 4	No. 8	No. 30	No. 200[a]
Coarse aggregates	6AAA[b]	602, 1004	—	—	100	90–100	60 – 85	30–60	—	0–8	—	—	≤1.0[c]
	6AA[b]	406, 602, 706, 708, 806, 1004, 1006	—	—	100	95–100	—	30–60	—	0–8	—	—	≤1.0[c]
	6A	206, 401, 402, 406, 602, 603, 706, 806, 1004, 1006	—	—	100	95–100	—	30–60	—	0–8	—	—	≤1.0[c]
	17A	401, 406, 706, 708, 1004	—	—	—	100	90–100	50–75	—	0–8	—	—	≤1.0[c]
	25A		—	—	—	—	100	95–100	60–90	5–30	0–12	—	≤3.0
	26A	706, 712, 1004, 1006	—	—	—	—	100	95–100	60–90	5–30	0–12	—	≤3.0
	29A	1004	—	—	—	—	—	100	90–100	10–30	0–10	—	≤3.0
Dense-graded aggregates	21AA	302, 304, 305, 306, 307	—	—	100	85–100	—	50–75	—	—	20–45	—	4–8[d][e]
	21A	302, 305, 306, 307	—	—	100	85–100	—	50–75	—	—	20–45	—	4–8[d][e]
	22A	302, 305, 306, 307	—	—	—	100	90–100	—	65–85	—	30–50	—	4–8[d][e,f]
	23A	306, 307	—	—	—	100	—	—	60–85	—	25–60	—	9–16[e]
	23AA	306, 307	—	—	—	100	—	—	60–85	—	25–60	—	9–16[e]

Table 902-1 (cont.):
Grading Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open-Graded Aggregates

Material Type	Series/ Class	Item of Work by Section Number (Sequential)	Sieve Analysis (MTM 109) Total % Passing[a]										LBW (MTM 108) % Passing
			2½ inch	2 inch	1½ inch	1 inch	¾ inch	½ inch	⅜ inch	No. 4	No. 8	No. 30	No. 200[a]
Open-graded aggregates	4G [g]	303	—	—	100	85–100	—	45–65	—	—	15–30	6–18	≤6.0
	4G [h]	303	—	—	100	85–100	—	45–70	—	—	15–35	8–22	≤8.0
	34R	401, 404, 406	—	—	—	—	—	100	90–100	—	0 – 5	—	≤3.0
	34G	404, 406	—	—	—	—	—	100	95–100	—	0 – 5	—	≤3.0
	46G	206, 208, 401, 402, 406, 916	—	—	100	95-100	—	30-60	—	0-8	—	—	≤3.0

(a) Based on dry weights.

(b) Class 6AAA will be used exclusively for all mainline and ramp concrete pavement when the directional commercial ADT is greater than or equal to 5,000 vehicles per day. Other requirements apply for high-performance concrete.

(c) Loss by washing (LBW) will not exceed 2.0% for material produced entirely by crushing rock, boulders, cobbles, slag, or concrete.

(d) When used for aggregate base courses, surface courses, shoulders, and approaches and the material is produced entirely by crushing rock, boulders, cobbles, slag, or concrete, the maximum limit for LBW must not exceed 10%.

(e) The limits for LBW of dense-graded aggregates are significant to the nearest whole percent.

(f) For aggregates produced from sources in Berrien County, the LBW must not exceed 8% and the sum of LBW, and shale particles must not exceed 10%.

(g) Gradation prior to placement and compaction.

(h) Gradation compacted in-place, sampled from the grade in accordance with MTM 119.

Table 902-2:
Physical Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open-Graded Aggregates[a]

		Gravel, Stone, and Crushed Concrete						Slag[b]		All Aggregates
Material Type	**Series/ Class**	**Crushed Material, % min. (MTM 117)**	**Loss, % max, LA Abrasion (MTM 102)**	**Soft Particles, % max. (MTM 110)**	**Chert, % max. (MTM 110)**	**Sum of Soft Particles and Chert, % max. (MTM 110)**	**Freeze-Thaw Dilation, % per 100 cycle max. (MTM 115)[c]**	**Sum of Coke and Coal Particles, % max. (MTM 110)**	**Freeze-Thaw Dilation, % per 100 cycles max. (MTM 115)[c]**	**Flat and Elongated Particles, ratio % max. (ASTM D4791) (MTM 130)**
Coarse aggregates[d]	6AAA	—	40	2.0[e]	2.5	4.0	0.040[f]	1.0	0.040[f]	3:1–15.0[g]
	6AA[h]	—	40	2.0[e]	—	4.0	0.067[i]	1.0	0.067	—
	6A[h]	—	40	3.0[e]	7.0	9.0	0.067	1.0	0.067	—
	17A[h]	—	40	3.5[e]	8.0	10.0	0.067[i]	1.0	0.067	—
	25A	95	45	8.0[j]	—	8.0	—	1.0	—	3:1–20.0[k]
	26A[h]	—	40	2.0[e]	—	4.0	0.067	1.0	0.067	—
	29A	95	45	8.0[j]	—	8.0	—	1.0	—	3:1–20.0[k]
Dense-graded aggregates[l]	21AA	95	50	—				—		—
	21A	25	50	—				—		—
	22A	25	50	—				—		—
	23A	25	50	—				—		—
	23AA	95	50	—				—		—

Table 902-2 (cont.):
Physical Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open-Graded Aggregates[a]

Material Type	Series/ Class	Gravel, Stone, and Crushed Concrete						Slag[b]		All Aggregates
		Crushed Material, % min. (MTM 117)	Loss, % max, LA Abrasion (MTM 102)	Soft Particles, % max. (MTM 110)	Chert, % max. (MTM 110)	Sum of Soft Particles and Chert, % max. (MTM 110)	Freeze-Thaw Dilation, % per 100 cycle max. (MTM 115)[c]	Sum of Coke and Coal Particles, % max. (MTM 110)	Freeze-Thaw Dilation, % per 100 cycles max. (MTM 115)[c]	Flat and Elongated Particles, ratio % max. (ASTM D4791) (MTM 130)
Open-graded aggregates	4G	95	45[m]	—				—		—
	34R	≤20	45[m]	—				—		—
	34G	100	45[m]	—				—		—
	46G	95	45[m]	—				—		—

Table 902-2 (cont.):
Physical Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open-Graded Aggregates[a]

(a) See subsections 902.03.B, 902.05, and 902.06 for additional physical requirements for coarse aggregate, dense-graded aggregates, and open-graded aggregates, respectively.

(b) Iron blast furnace and reverberatory furnace slag must contain no free (unhydrated) lime.

(c) If the relative density (OD) is >0.04 less than the relative density (OD) of the most recently tested freeze-thaw sample, the aggregate will be considered to have changed characteristics and be required to have a new freeze-thaw test per MTM 113 conducted prior to use on Department projects.

(d) Grade 3500 concrete requires an optimized aggregate gradation as specified in section 604. Use aggregates only from geologically natural sources.

(e) Clay-ironstone particles must not exceed 1.0% for 6AAA, 6AA, and 26A, and 2.0% for 6A and 17A. Clay-ironstone particles are also included in the percentage of soft particles for these aggregates.

(f) Maximum freeze-thaw dilation is 0.067 when the directional commercial ADT is less than 5,000 vehicles per day. Maximum dilation is 0.040 for all high-performance concrete.

(g) ASTM D4791 Section 8.4 will be followed. The test will be performed on the material retained down to and including the 3/8-inch sieve.

(h) Except for pre-stressed beams, the sum of soft and chert particles may be up to 3.0% higher than the values determined from the sample tested for freeze-thaw durability. However, under no circumstances will the deleterious particle percentages exceed the specification limits in Table 902-2. In addition, a source may be restricted to a minimum percent crushed not to exceed 15% less than the percent crushed in the freeze-thaw sample. When the freeze-thaw dilation is between 0.040 and 0.067% per 100 cycles, more restrictive limits will be applied.

(i) Maximum dilation of 0.010 for pre-stressed concrete beams.

(j) Friable sandstone is included in the soft particle determination for chip seal aggregates.

(k) ASTM D4791 Section 8.4 will be followed. The test will be performed on the material retained down to and including the No. 4 sieve.

(l) Quarried carbonate (limestone or dolomite) aggregate may not contain over 10% insoluble residue finer than No. 200 sieve when tested in accordance with MTM 103.

(m) If a blend of different aggregate sources, the abrasion value applies to each source.

Table 902-3:
Grading Requirements for Granular Materials

Material	Sieve Analysis (MTM 109), Total % Passing[a]									LBW % Passing No. 200[a][b]
	6 inch	3 inch	2 inch	1 inch	½ inch	⅜ inch	No. 4	No. 30	No. 100	
Class I	—	—	100	—	45–85	—	20–85	5–30	—	0–5
Class II[c]	—	100	—	60–100	—	—	50–100	—	0–30	0–7
Class IIA[c]	—	100	—	60–100	—	—	50–100	—	0–35	0–10
Class IIAA	—	100	—	60–100	—	—	50–100	—	0–20	0–5
Class III	100	95–100	—	—	—	—	50–100	—	—	0–15
Class IIIA	—	—	—	—	—	100	50–100	—	0–30	0–15

(a) Test results based on dry weights.

(b) Use test method MTM 108 for LBW.

(c) Except for use in granular blankets, Class IIA granular material may be substituted for Class II granular material for projects in the following counties: Arenac, Bay, Genesee, Gladwin, Huron, Lapeer, Macomb, Midland, Monroe, Oakland, Saginaw, Sanilac, Shiawassee, St. Clair, Tuscola, and Wayne.

Table 902-4:
Grading Requirements for Fine Aggregates

Material	Sieve Analysis (MTM 109), Total % Passing[a]							LBW % Passing No. 200[a][b]	Fineness Modulus Variation[c]
	⅜ inch	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100		
2NS	100	95–100	65–95	35–75	20–55	10–30	0–10	0–3.0	±0.20[d]
2SS[e]	100	95–100	65–95	35–75	20–55	10–30	0–10	0–4.0	±0.20[d]
2MS	—	100	95–100	—	—	15–40	0–10	0–3.0	±0.20[d]

(a) Test results based on dry weights.

(b) Use test method MTM 108 for LBW.

(c) Aggregate having a fineness modulus differing from the base fineness modulus of the source by the amount exceeding the maximum variation specified in the table will be rejected. Use ASTM C136.

(d) The base fineness modulus will be supplied by the aggregate producer at the start of each construction season and be from 2.50 to 3.35. The base fineness modulus, including the permissible variation, will be from 2.50 to 3.35.

(e) Quarried carbonate (limestone or dolomite) cannot be used for any application subject to vehicular traffic.

Table 902-5:
Superpave Final Aggregate Blend Gradation Requirements

	Mix Number				
Standard Sieve	**5**	**4**	**3 Leveling Course**	**3 Base Course**	**2**
	% Passing Criteria (Control Points)				
1½ inch	—	—	—	—	100
1 inch	—	—	100	100	90–100
$^{3}/_{4}$ inch	—	100	90–100	90–100	≤90
$^{1}/_{2}$ inch	100	90–100	≤90	≤90	—
$^{3}/_{8}$ inch	90–100	≤90	—	—	—
No. 4	≤90	—	—	—	—
No. 8	47–67	39–58	35–52	23–52	19–45
No. 16	—	—	—	—	—
No. 30	—	—	—	—	—
No. 50	—	—	—	—	—
No. 100	—	—	—	—	—
No. 200	2.0–10.0	2.0–10.0	2.0–8.0	2.0–8.0	1.0–7.0

Table 902-6:
Superpave Final Aggregate Blend Physical Requirements

Est. Traffic (million ESAL)	Mix Type	Minimum Criteria						Maximum Criteria					
		% Crushed[a]		Fine Aggregate Angularity		% Sand Equivalent		LA Abrasion % Loss[b]		% Soft Particles[c]		% Flat and Elongated Particles[d]	
		Course(s)						Course(s)					
		Top and Leveling	Base	Top and Leveling	Base	Top and Leveling	Base	Top and Leveling	Base	Top and Leveling	Base	Top and Leveling	Base
<0.3	EL	55 / —	—	—	—	40	40	45	45	10	10	—	—
≥0.3 – <3	EML	75 / —	50 / —	43	40	40	40	35	40	5	5	10	10
≥3 – <30	EMH	90 / 85	80 / 75	45	40	45	45	35	35	3	4.5	10	10
≥30 – <100	EH	100 / 100	95 / 90	45	45	50	50	35	35	3	4.5	10	10

ESAL = equivalent single-axle load

(a) XX / YY denotes that XX% of the coarse aggregate has one fractured face and YY% has at least two fractured faces.

(b) If a blend of different aggregate sources, the abrasion value applies to each source.

(c) Soft particles maximum is the sum of the shale, siltstone, ochre, coal, clay-ironstone, and particles that are structurally weak or non-durable in service.

(d) Maximum by mass with a 1:5 aspect ratio.

Table 902-7:
Capital Preventive Maintenance Final Aggregate Blend Gradation Requirements

	Mechanical Analysis, Total % Passing										
Material	**¾ inch**	**½ inch**	**⅜ inch**	**¼ inch**	**No. 4**	**No. 8**	**No. 16**	**No. 30**	**No. 50**	**No. 100**	**No. 200[a]**
27SS	100	85–100	55–80	—	22–38	19–32	15–24	11–18	8–14	5–10	4–7[b]
30SS	—	100	85–100	—	22–38	19–32	15–24	11–18	8–14	5–10	4–7[b]
34CS[c]	100	100	90–100	—	0–15	0–5	—	—	—	—	≤2
CS-T[c]	100	100	100	85–100	—	0–15	—	—	—	—	≤2
2FA	—	—	100	—	90–100	65–90	45–70	30–50	18–30	10–21	5–15[b]
3FA	—	—	100	—	70–90	45–70	28–50	19–34	12–25	7–18	5–15[b]

(a) Includes mineral filler.
(b) No. 200 limits are significant to the nearest whole percent.
(c) All aggregate must be washed.

Table 902-8:
Capital Preventive Maintenance Aggregate Blend Physical Requirements

Material		% Crushed (Min.) MTM 117[k]	Angularity Index (Min.) MTM 118	Uncompacted Void (Min.) AASHTO T304	LA Abrasion (% Loss Max.) MTM 102[f]	Aggregate Wear Index (AWI) (Min.) MTM 111, 112[h]	Soft Particles (% Max.) MTM 110	Sand Equivalent (% Min.) AASHTO T176	Flat, Elongated, or Flat and Elongated (% Max.) ASTM D4791	Absorp. (% Max.) AASHTO T85	Micro-Deval (% Loss Max.) AASHTO T327
27SS[e]		100 / 90	—	40	35	260	5.0[a]	45	25.0[b]	3.0	18
30SS[e]		100 / 90	—	40	35	260	5.0[a]	45	25.0[b]	3.0	18
34CS[j]	ADT ≥ 4,000	100 / 90	—	—	35[g]	260[i]	3.5[a]	—	15.0[b]	—	—
	ADT < 4,000	95 / 85	—	—	35[g]	220	3.5[a]	—	15.0[b]	—	—
CS-T[j]	ADT ≥ 4,000	100 / 90	—	—	35[g]	260[i]	3.5[a]	—	—	—	—
	ADT < 4,000	95 / 85	—	—	35[g]	220	3.5[a]	—	—	—	—
2FA		—	4.0[c]	—	45	260	—	60[d]	—	—	—
3FA		—	4.0	—	45	260	—	60	—	—	—

(a) Sum of shale, siltstone, clay-ironstone, and structurally weak.

(b) For material retained on the No. 4 sieve and above, ensure that the ratio between length to width, width to thickness, and length to thickness is no greater than 3:1.

(c) Angularity Index must exceed 2.0 for at least 50% of the blending sands for slurry seal applications.

(d) Does not apply to slurry seals.

(e) Must be 100% virgin aggregate.

(f) If a blend of different aggregate sources, the abrasion value applies to each source.

(g) Natural aggregate. LA abrasion maximum loss of 45% for iron blast-furnace slag aggregate.

(h) Does not apply to a shoulder chip seal or interlayer application.

(i) Single-chip seals. For double-chip seals, a 260 min. AWI of a 60/40 weighted average in which the top course will be weighted at 60% and base course will be weighted at 40% with the higher AWI aggregate as the top course.

(j) Moisture content at time of placement ≤4%.

(k) XX / YY denotes that XX% of the coarse aggregate has one fractured face and YY% has at least two fractured faces.

Section 903. Admixtures and Curing Materials for Concrete

903.01. Air-Entraining Admixtures

Select liquid air-entraining admixtures for Portland cement concrete from the Qualified Products List.

903.02. Liquid Chemical Admixtures

Select liquid chemical admixtures for use in Portland cement concrete from the Qualified Products List. Liquid chemical admixtures must not contain a chloride ion content greater than 0.5% by weight.

The Department uses the following ASTM C494/C494M terms for chemical admixtures:

Table 903-1:
ASTM C494/C494M Terms for Chemical Admixtures

Type	Term
A	Water-reducing admixtures
C	Accelerating admixtures
D	Water-reducing and -retarding admixtures
E	Water-reducing and -accelerating admixtures
F	Water-reducing, high-range admixtures
G	Water-reducing, high-range, and -retarding admixtures

The Department refers to water-reducing and mid-range admixtures not included in ASTM C494/C494M as Type MR.

903.03. Latex Admixtures

Formulated latex admixture for modifying mortar or concrete mixtures must be a non-toxic, film forming, polymeric emulsion to which all stabilizers are added at the point of manufacture. Latex admixtures must be homogeneous and uniform in composition.

A. **Physical Properties.** White latex styrene butadiene modifier must have between 46.0 and 49.0% solids; pH, as shipped, between 8.5 and 11.0; and a shelf life of at least 2 years.

B. **Storage.** Protect latex admixtures from freezing. Do not expose latex admixtures to temperatures greater than 85°F for more than 10 days.

903.04. Calcium Chloride Concrete Accelerators

Do not use calcium chloride in prestressed concrete, superstructure concrete, concrete for bridge railings, or concrete containing galvanized steel or aluminum.

Flake or pellet calcium chloride for on-the-job preparation of admixture solutions must meet the requirements of ASTM D98 for 77% grade or 94% grade. Determine the percentage of calcium and magnesium chlorides in accordance with ASTM D345. Provide flake or pellet Type S (solid) material.

Calcium chloride admixture, delivered to the job in solution, must conform to the following chemical composition:

A. From 32.0 to 35.0% calcium chloride ($CaCl_2$) anhydrous;

B. No greater than 1.0% total magnesium as $MgCl_2$;

C. No greater than 2.0% total alkali chlorides calculated as NaCl; and

D. No greater than 0.5% other impurities.

903.05. Polypropylene Fibers

Use 100% virgin polypropylene fibers, ¾ inch long, that meet the requirements of ASTM C1116/C1116M, Type III.

903.06. Concrete Curing Materials for Pavements

A. **White Membrane Curing Compound.** White membrane curing compound must meet the requirements of ASTM C309, Type 2, and be packaged in clean containers.

   Before use and before transferring the compound between containers, agitate the compound to a uniform consistency and ensure that pigment is uniformly suspended.

B. **Transparent Membrane Curing Compound for Base Course.** Transparent membrane curing compound must meet the requirements of ASTM C309, Type 1-D, Class B with fugitive dye.

903.07. Concrete Curing Materials for Structures

A. **White Membrane Curing Compound for Bridge Decks.** Provide white-pigmented, modified, linseed-oil-based material that is either water soluble or an emulsion type that meets the requirements of ASTM C309, Type 2, except that the reflectance requirement and drying time do not apply. Compound must be packaged in clean containers.

Before transferring the compound between containers and applying, agitate the compound to a uniform consistency and ensure uniform suspension of the pigment.

B. **Transparent Membrane Curing Compound.** Transparent membrane curing compound must meet the requirements of ASTM C309, Type 1-D, Class B, with fugitive dye.

C. **Insulating Blankets.** Insulating blankets must have vapor-retarding liners that completely enclose the insulating mat, are bonded to both sides of the insulating mat, and have one reflective face. Blankets must have thicknesses or R-values meeting the requirements of Table 706-1.

Insulating blanket must have a thermal conductivity (k) no greater than 0.27 BTU per hour per square foot temperature gradient of 1°F per inch of thickness at a mean temperature of 75°F when tested in accordance with ASTM C177.

D. **Polystyrene Insulation.** Expanded polystyrene must be cut from preformed material with an average cell diameter no greater than 0.04 inch and as specified in Table 903-2:

Table 903-2:
Polystryene Insulation Specifications

Property	Specification	Test Method
Density	≥0.90 lb/ft³	ASTM C303
Compressive strength	≥9.0 psi	ASTM D1621
Flexural strength	≥25.0 psi	ASTM C203
Water absorption	≤2.0% by volume	ASTM C272/C272M
Thermal conductivity	≤0.27 BTU/hr/ft²[(a)]	ASTM C177

(a) For a temperature gradient of 1°F per inch of thickness at a mean temperature of 75°F

Section 904. Asphaltic Materials

904.01. General Requirements

The certification program described in MDOT's *Materials Quality Assurance Procedures Manual* governs the asphalt binders in Table 904-1 and the emulsified asphalts in Table 904-4, Table 904-5, and Table 904-6. The Contractor may use materials listed in Table 904-2 through Table 904-7 on MDOT projects if tested and approved for use in accordance with MDOT procedures.

The Engineer will notify the Contractor and the supplier to correct materials if test results for the requirements from Table 904-2, Table 904-3, Table 904-4, Table 904-5, Table 904-6, and Table 904-7 deviate from the specified range.

Asphaltic materials testing will be in accordance with the specified ASTM, AASHTO, or Department methods, as modified by this section.

904.02. Application Temperatures

Apply asphaltic materials at temperatures specified in Table 904-7.

904.03. Specific Requirements

A. **Asphalt Binder.** Asphalt binder must be homogeneous and water-free and must not foam when heated to the maximum temperature specified in Table 904-7 for the material required.

If using an anti-foaming agent, use a dimethyl polysiloxane type silicone material, preferably 1000 centistoke viscosity grade unless otherwise approved by the Engineer. Do not add amounts greater than 5 parts per million unless approved by the Engineer. Mechanically mix the asphalt binder after adding anti-foaming agent while in storage at the asphalt plant.

Asphalt binder must be prepared by refining crude petroleum with or without the addition of modifiers. Asphalt binder prepared with reclaimed engine-oil-based products is prohibited.

Organic, virgin, or recycled modifiers that are dissolved, dispersed, or reacted in asphalt cement to enhance performance are allowed.

Asphalt binder must be at least 99.0% soluble in accordance with AASHTO T44 or ASTM D2042.

This specification (subsection 904.03.A) is not applicable for asphalt binders in which fibers or other discrete particles are larger than 250 micrometers.

B. **Cutback Asphalt.** Cutback asphalt must meet the requirements of Table 904-3 and this subsection.

Liquid asphalt must be homogeneous, must not foam when heated to the maximum required temperature, and must be water free unless otherwise required.

Caution: Use caution when heating cutback asphalt, especially rapid-curing (RC) and medium-curing (MC) asphaltic products containing naphtha and kerosene cutback asphalt since the temperatures for use are near or above the flash points. If using heated cutbacks, keep open flames away from pugmill enclosures, tank car domes, distributor tank openings, and storage tank openings.

C. **Emulsified Asphalt.** Emulsified asphalt must meet the requirements of Table 904-4, Table 904-5, Table 904-6, or Table 904-7 and be made from asphalt having a negative spot test result using 35% xylene / 65% heptane solvent, aniline number: 30°C ± 2°C, AASHTO T102. It must be homogeneous and show no separation of asphalt after thorough mixing for a period of at least 30 days after delivery.

Table 904-1:
Performance-Graded Asphalt Binder Specification (PG 46, PG 52, and PG 58)

	PG 46			PG 52							PG 58				
Specification	**−34**	**−40**	**−46**	**−10**	**−16**	**−22**	**−28**	**−34**	**−40**	**−46**	**−16**	**−22**	**−28**	**−34**	**−40**
Pavement Design Temperature															
Avg 7-day max. pavement design temp, °C[(a)]	46			52							58				
Minimum pavement design temp, °C[(a)]	−34	−40	−46	−10	−16	−22	−28	−34	−40	−46	−16	−22	−28	−34	−40
Original Binder															
Flash Point Temp, T48/D 92: Min.	230°C			230°C							230°C				
Viscosity, T316/D4402: Max. 3 Pa•s, Test Temp[(b)]	135°C			135°C							135°C				
Dynamic Shear, T315/D7175: G*/sin θ, Min. 1.00 kPa test temp at 10 rad/s[(c),(d)]	46°C			52°C							58°C				
Rolling Thin Film Oven (T240/D2872)															
Mass loss, max.	1.00%			1.00%							1.00%				
Dynamic Shear, T315/D7175: G*/sin θ, Min. 2.20 kPa test temp at 10 rad/s[(d)]	46°C			52°C							58°C				
Pressure Aging Vessel (PAV) Residue (R28/D6521)															
PAV aging temp[(e)]	90°C			90°C							100°C				
Dynamic shear, T315/D7175: G*sin θ, max. 5000 kPa test temp at 10 rad/s, °C[(d)]	10	7	4	25	22	19	16	13	10	7	25	22	19	16	13
Physical hardening[(f)]	Report			Report							Report				
Creep stiffness, T313/D6648: S, max. 300 MPa, m-value, min. 0.300 test temp at 60 s, °C	−24	−30	−36	0	−6	−12	−18	−24	−30	−36	−6	−12	−18	−24	−30

Table 904-1 (cont.):
Performance-Graded Asphalt Binder Specification (PG 46, PG 52, and PG 58)

(a) Pavement temperatures may be estimated from air temperatures using an algorithm contained in the Long-Term Pavement Performance (LTPP) Bind program, may be provided by the specifying agency, or may be estimated by following the procedures in AASHTO M 323 and R-35.

(b) This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

(c) For quality control (QC) of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be used or supplement dynamic shear measurements of $G^*/\sin\theta$ at test temperatures where the asphalt is a Newtonian fluid. The Contractor may use a standard means of viscosity measurement, including capillary (T201/D2170 or T202/D2171) or rotational viscometer (T316/D4402).

(d) $G^*/\sin\theta$ = high temperature stiffness and $G^*\sin\theta$ = intermediate temperature stiffness.

(e) The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures: 90°C, 100°C, or 110°C. The PAV aging temperature is 100°C for PG 58- and above, except in desert climates, where it is 110°C.

(f) Physical hardening – T313/D6648 is performed on a set of asphalt beams according to ASTM D6648, Section 13.1, except that the conditioning time is extended to 24 hours ±10 minutes at 10°C above the minimum performance temperature. The 24-hour stiffness and m-value are reported for information purposes only.

Table 904-2:
Performance-Graded Asphalt Binder Specification (PG 64 and PG 70)

	PG 64						PG 70					
Specification	**−10**	**−16**	**−22**	**−28**	**−34**	**−40**	**>−10**	**−16**	**−22**	**−28**	**−34**	**−40**
Pavement Design Temperature												
Avg 7-day max. pave design temp[a]	64°C						70°C					
Minimum pavement design temp, °C[a]	−10	−16	−22	−28	−34	−40	−10	−16	−22	−28	−34	−40
Original Binder												
Flash point temp, T48/D92: min.	230°C						230°C					
Viscosity, T316/D4402: max. 3 Pa•s, test temp[b]	135°C						135°C					
Dynamic shear, T315/D7175: G*/sin θ, min. 1.00 kPa test temp at 10 rad/s[c],[d]	64°C						70°C					
Rolling Thin Film Oven (T240/D2872)												
Mass loss, max.	1.00%						1.00%					
Dynamic shear, T315/D7175: G*/sin θ, min. 2.20 kPa test temp at 10 rad/s[d]	64°C						70°C					
Pressure Aging Vessel Residue (R28/D6521)												
PAV aging temp, °C[e]	100						100 (110)					
Dynamic shear, T315/D7175: G*sin θ, max. 5000 kPa test temp at 10 rad/s, °C[d]	31	28	25	22	19	16	34	31	28	25	22	19
Physical hardening[f]	Report						Report					
Creep stiffness, T313/D6648: S, max. 300 MPa, m-value, min. 0.300 test temp at 60 s, °C	0	−6	−12	−18	−24	−30	0	−6	−12	−18	−24	−30

Table 904-2 (cont.):
Performance-Graded Asphalt Binder Specification (PG 64 and PG 70)

(a) Pavement temperatures may be estimated from air temperatures using an algorithm contained in the Long-Term Pavement Performance (LTPP) Bind program, may be provided by the specifying agency, or may be estimated by following the procedures in AASHTO M 323 and R-35.

(b) This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

(c) For QC of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be used or supplement dynamic shear measurements of G*/sin θ at test temperatures where the asphalt is a Newtonian fluid. The Contractor may use a standard means of viscosity measurement, including capillary (T201/D2170 or T202/D2171) or rotational viscometer (T316/D4402).

(d) G*/sin θ = high temperature stiffness and G*sin θ = intermediate temperature stiffness.

(e) The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures 90°C, 100°C or 110°C. The PAV aging temperature is 100°C for PG 58 and above, except in desert climates, where it is 110°C.

(f) Physical hardening – T313/D6648 is performed on a set of asphalt beams according to ASTM D6648, Section 13.1, except that the conditioning time is extended to 24 hours ±10 minutes at 10°C above the minimum performance temperature. The 24-hour stiffness and m-value are reported for information purposes only.

Table 904-3:
Performance Graded Asphalt Binder Specification (PG 76 and PG 82)

	PG 76					PG 82				
Specification	**−10**	**−16**	**−22**	**−28**	**−34**	**−10**	**−16**	**−22**	**−28**	**−34**
Pavement Design Temperature										
Avg 7-day max. pave design temp[a]	76°C					82°C				
Minimum pavement design temp, °C[a]	−10	−16	−22	−28	−34	−10	−16	−22	−28	−34
Original Binder										
Flash point temp, T48/D92: min.	230°C					230°C				
Viscosity, T316/D 4402: max. 3 Pa•s, test temp[b]	135°C					135°C				
Dynamic shear, T315/D7175: G*/sin θ, min. 1.00 kPa test temp at 10 rad/s[c],[d]	76°C					82°C				
Rolling Thin Film Oven (T240/D2872)										
Mass loss, max. percent	1.00					1.00				
Dynamic shear, T315/D7175: G*/sin θ, min. 2.20 kPa test temp at 10 rad/s[d]	76°C					82°C				
Pressure Aging Vessel Residue (R28/D6521)										
PAV aging temp, °C[e]	100 (110)					100 (110)				
Dynamic shear, T315/D7175: G*sin θ, max. 5000 kPa test temp at 10 rad/s, °C[d]	37	34	31	28	22	40	37	34	31	28
Physical hardening[f]	Report					Report				
Creep stiffness, T313/D6648: S, max. 300 MPa, m-value, min. 0.300 test temp at 60 s, °C	0	−6	−12	−18	−24	0	−6	−12	−18	−24

Table 904-3 (cont.):
Performance Graded Asphalt Binder Specification (PG 76 and PG 82)

(a) Pavement temperatures may be estimated from air temperatures using an algorithm contained in the Long-Term Pavement Performance (LTPP) Bind program, may be provided by the specifying agency, or may be estimated by following the procedures in AASHTO M 323 and R-35.

(b) This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.

(c) For QC of unmodified asphalt cement production, measurement of the viscosity of the original asphalt cement may be used or supplement dynamic shear measurements of $G^*/\sin\theta$ at test temperatures where the asphalt is a Newtonian fluid. The Contractor may use a standard means of viscosity measurement, including capillary (T201/D2170 or T202/D2171) or rotational viscometer (T316/D4402).

(d) $G^*/\sin\theta$ = high temperature stiffness and $G^*\sin\theta$ = intermediate temperature stiffness

(e) The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures 90°C, 100°C or 110°C. The PAV aging temperature is 100°C for PG 58 and above, except in desert climates, where it is 110°C.

(f) Physical hardening – T313/D6648 is performed on a set of asphalt beams according to ASTM D6648, Section 13.1, except that the conditioning time is extended to 24 hours ±10 minutes at 10°C above the minimum performance temperature. The 24-hour stiffness and m-value are reported for information purposes only.

Table 904-4:
Medium and Rapid Curing Cutback Asphalts

	Requirements			
Test	**MC-30[a]**	**MC-70[a]**	**MC-250**	**RC-250**
Kinematic viscosity, 60°C, mm²/s, T201/D2170	30–60	70–140	250–500	250–500
Flash point, °C:				
Tag open cup, min., T 79	37.8	37.8	—	26.7
Cleveland open cup, min., T 48/D 92	—	—	65.6	—
Distillation test, T78/D402:				
Distillate, % by vol of total distillate to 360°C				
To 225°C	≤25	≤20	≤10 max.	≥35
To 260°C	40–70	20–60	15–55	≥60
To 315.5°C	75–93	65–90	60–87	≥80
Residue from distillation to 360°C, min.	50	55	67	65
Tests on residue from distillation, T78/D402:				
Penetration at 25°C, 100 g, 5 sec, T 49/D 5	120–250	120–250	120–250	80–120
Ductility at 25°C, cm, min., T51/D113[b]	100	100	100	100
Solubility in trichloroethylene, %, min., T44/D2042	99.5	99.5	99.5	99.5
Spot test, AASHTO T102[c]	Neg.	Neg.	Neg.	Neg.
Section number reference	—	914	—	710, 914

(a) Use MC-70 grade from June 1 to September 1 and MC-30 grade other times of the year, unless otherwise directed by the Engineer.

(b) If penetration of residue exceeds 200 and ductility at 25°C is less than 100, the Engineer will accept the material if ductility at 15.6°C exceeds 100.

(c) Use 35% xylene, 65% heptane solvent, aniline number: 30°C ± 2°C.

Table 904-5:
Anionic Emulsified Asphalts

Test	Anionic Emulsified Asphalt Requirements								
	RS-1m	**RS-2a**	**HFRS-2**	**MS-Op**	**MS-2h**	**MS-2s**	**SS-1h**	**LTBC-1**	**LTBC-2**
Viscosity, Saybolt Furol, T59/D7496									
At 25°C, sec	20–100	—	—	—	—	—	20–100	15–100	15–100
At 50°C, sec	—	50–300	50–300	15–150	50–300	50–300	—	—	—
Storage stability test, T59/D6930, 24-hour, % difference max.	2	2	2	3	3	3	2	1	—
Settlement and storage stability test, T59/D6930, 5-day, % difference max.	—	—	—	—	—	—	—	5	5
Demulsibility, T59/S6936:									
35 ml 0.02 N CaCl2, %	20–60	≥60	≥40	—	—	—	—	—	—
50 ml 0.1 N CaC12, %	—	—	—	—	—	—	≤2	—	—
50 ml 0.02 N CaCl2, %	—	—	—	—	—	—	—	—	—
Sieve Test, T59/D6933, % max.	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.30	0.30
Miscibility with water, D244[(a)]	—	—	—	—	—	—	Yes	—	—
Distillation to 260°C, T59/D6997, % by weight:									
Residue, min.	65	65	65	65	65	65	60	50	50
Oil distillate, max.	2	2	2	25	7	7	2	1	1
Tests on distillation residue:									
Penetration, 25°C, 100 g, 5 sec, dmm, T49/D5	100–200	100–200	100–200	[(b)]	150–300	≥300	40–90	≤20	≤40

Table 904-5 (cont.):
Anionic Emulsified Asphalts

Test	Anionic Emulsified Asphalt Requirements								
	RS-1m	**RS-2a**	**HFRS-2**	**MS-Op**	**MS-2h**	**MS-2s**	**SS-1h**	**LTBC-1**	**LTBC-2**
Float test, sec, T50/D139									
At 50°C, max.	—	—	—	200	—	—	—	—	—
At 60°C, min.	—	—	1200	—	1200	1200	—	—	—
Ductility, 25°C, cm, min., T51/D113	60	60	60	40[(b)]	—	—	40	—	—
Solubility in trichloroethylene, % min., T44/D2042	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
Ash content, %, max., D128	2	2	2	2	2	2	2	—	—
Specific gravity, 25/25°C, min., T 228/D 70	0.996	0.996	0.996	—	—	—	—	—	—
Toughness/tenacity, 25°C, 50 cm/min., Nm, min., D 5801	—	—	—	—	—	—	—	—	—
Elastic recovery, 10°C, % min., T 301/D 6084	—	—	—	—	—	—	—	—	—
Softening point, ring and ball, °C, min., T53/D36	—	—	—	—	—	—	—	60	—
Section number reference	—	401	—	501	—	501	501, 805	501, 805	501, 805

(a) No appreciable coagulation or visible separation in 2 hours.

(b) Heat the distillation residue (ASTM D243/D243M) to 100±15 penetration within 2 hours and have a ductility of at least 40 cm.

Nm = Newton meter

Table 904-6:
Cationic Emulsified Asphalts

Test	Cationic Emulsified Asphalts Requirements			
	CRS-1	CRS-2	CMS-2	CSS-1h
Viscosity, Saybolt Furol, T59/D7496:				
At 25°C, sec	—	—	—	20–100
At 50°C, sec	20–100	100–400	50–450	—
Storage stability tests, T59/D6930 04, 24 hr, % difference, max.	1	1	1	1
Demulsibility, %, 35 ml 0.8% dioctyl sodium sulfosuccinate, min., T 59/D 6936[(a)]	40	40	—	—
Particle charge tests, T59/D7402[(b)]	Positive	Positive	Positive	Positive
Sieve tests, T59/D6933, % max. (distilled water)	0.10	0.10	0.10	0.10
Distillation to 260°C, T59/D6997, % by weight	—	—	—	—
Residue, min.	60	65	65	60
Oil distillate, max.	3	3	12	—
Tests on distillation residue:				
Penetration, 25°C, 100 g, 5 sec, dmm, T49/D5	100–250	100–250	100–250	40–90
Ductility, 25°C, 5 cm/min, cm, min., T51/D113	40	40	40	40
Ductility, 4°C, 5 cm/min, cm, T51/D113	—	—	—	—
Elastic/recovery, 4°C,% min., T301/D6084	—	—	—	—
Solubility in trichloroethylene, % min., T44/D2042	97.5	97.5	97.5	97.5
Ash content, % max., D128	2	2	2	2
Specific gravity, 25/25°C, min., T228/D70	0.996	0.996	—	—

Table 904-6 (cont.):
Cationic Emulsified Asphalts

Test	Cationic Emulsified Asphalts Requirements			
	CRS-1	CRS-2	CMS-2	CSS-1h
Toughness/tenacity, 25°C, 50 cm/min., Nm, min., D5801	—	—	—	—
Elastic recovery, 10°C, % min., T301/D6084	—	—	—	—
Cement mixing test, T59/D6935, % max.	—	—	—	2.0
Coating ability and water resistance:				
Coating dry aggregate	—	—	Good	—
Coating after spraying	—	—	Good	—
Coating wet aggregate	—	—	Fair	—
Coating after spraying	—	—	Fair	—
Section number reference	—	—	501	501, 805

(a) The demulsibility test must be made within 30 days from date of shipment.

(b) If particle charge test is inconclusive, material having a maximum pH of 6.7 is acceptable.

Table 904-7:
Capital Preventive Maintenance Emulsions[a]

Test	Capital Preventive Maintenance Emulsion Requirements					
	HFRS-2M	**CRS-2M**	**CSS-1mM**	**CSS-1hM**	**PPSS**	**CSEA**
Viscosity, Saybolt Furol, T59/D7496:						
At 25°C, sec	—	—	20–100	20–100	20–100	—
At 50°C, sec	75–300	75–300	—	—	—	75–400
Storage stability test, T59/D6930, 24-hour, % difference max.	1	1	1	1	1[b]	1
Demulsibility, T59/D6936:						
35 ml 0.8% dioctyl sodium sulfosuccinate, % min.[c]	—	50	—	—	60	50
35 ml 0.02 N $CaCl_2$, %, min.	—	—	—	—	60	—
50 ml 0.1 N $CaC1_2$, %	—	—	—	—	—	—
50 ml 0.02 N $CaCl_2$, %	≥50	—	—	—	—	—
Particle charge tests, T59/D7402[d]		Positive	Positive	Positive	—	Positive
Sieve test, T59/ D6933, % max.	0.10	0.10	0.10	0.10	0.05	0.10
Miscibility with water, D244[e]	—	—	—	—	—	—
Distillation to 260°C, T59/D6997, % by weight:	[f]	[f],[g]	[f]	[f]	[f]	[g]
Residue, min.	65	65	62	62	63	68
Oil distillate, ml, max., D244	2	3	—	—	2	3.0
Tests on distillation residue:						
Penetration, 25°C, 100 g, 5 sec, dmm, T49/D5	80–150	80–150	70–90	40–90	80–150	70–100
Ductility, 25°C, 5 cm/min, cm, T51/D113	—	—	40	40	—	40

Table 904-7 (cont.):
Capital Preventive Maintenance Emulsions[a]

Test	Capital Preventive Maintenance Emulsion Requirements					
	HFRS-2M	CRS-2M	CSS-1mM	CSS-1hM	PPSS	CSEA
Ductility, 4°C, 5 cm/min, cm, T51/D113	—	—	35	—	—	—
Elastic/recovery, 4°C,% min., T301/D6084	—	—	65	—	—	—
Float test, sec, T50/D139:						
At 50°C, max.	—	—	—	—	—	—
At 60°C, min.	1200	—	—	—	—	—
Solubility in trichloroethylene, % min., T44/D2042	—	—	97.5	97.5	—	97.5
Ash content, %, max., D128	2	2	2	2	—	2
Specific gravity, 25/25°C, min., T228/D70	—	—	—	—	—	—
Toughness/tenacity, 25°C, 50 cm/min., Nm, min., D5801	4.5/3.5	4.5/3.5	—	—	—	9.0/7.0
Elastic recovery, 10°C, % min., T301/D6084	60%	60%	—	—	60%	75%
Tests on residue from evaporation, T59/D6934[h]						
Softening point, ring, and ball, °C, min., T53/D36	—	—	60	57.2	—	—
Viscosity, 60C, Pa•S, T202/D2171	—	—	800[i]	800[i]	—	—
Section number reference	—	505	504	501, 504	503	505

Table 904-7 (cont.):
Capital Preventive Maintenance Emulsions[(a)]

(a) Samples of emulsified asphalt will be taken in accordance with ASTM D140/D140M. Samples must be stored at a temperature of not less than 4°C until tested.

(b) After standing undisturbed for 24 hours, the surface must show no white, milky colored substance but must be a smooth homogenous color throughout. Any visible amount of white, milky colored substance is basis for non-acceptance.

(c) The demulsibility test must be made within 30 days from date of shipment.

(d) If particle charge test is inconclusive, material having a maximum pH of 6.7 is acceptable.

(e) No appreciable coagulation or visible separation in 2 hours.

(f) ASTM D6997, with modifications to include a 204°C (± 6°C) maximum temperature to be held for 15 minutes.

(g) Residue determination and preparation may use the alternative ASTM D6934 method, “Residue by Evaporation,” so as to not destroy the properties of any polymer modifiers contained therein.

(h) Residue by evaporation: Oven evaporate an emulsion sample on a glass plate at a maximum temperature of 60°C for 24 hours (forced draft oven recommended) or air dry the sample at ambient temperature for 3 days. Once dry, the sample is scraped from the plate using a razor blade tool.

(i) The minimum viscosity will be obtained using a Cannon-Manning Vacuum Capillary Viscometer Tube No. 14 per T202/D2171.

Table 904-8:
Temperatures for Asphaltic Materials

Asphalt Type	Designation	Temperature, °F Distributor
Cutback asphalts	RC-250	145–220
	MC-250	145–220
	MC-30	70–140
	MC-70	105–180
Emulsified	RS-1m, SS-1h, CSSmM, CRS-1, CSS-1h, CSS-1hM,	85–135
Asphalts	RS-2a, HFRS-2, HFRS-2M, MS-2h, MS-2s, CRS-2, CMS-2, CRS-2M	125–175
Asphalt binder	All grades	350 max. mixing temp[(a)]

(a) Mixing temperature for all asphalt binders will be as specified by the modifier/binder producer.

Section 905. Steel Reinforcement

905.01. General Requirements

Steel reinforcement for use in concrete structures and pavements must meet the requirements of this section.

905.02. Testing

Test steel reinforcement in accordance with ASTM A370, ASTM E8/E8M, or other specified ASTM, AASHTO, or Department methods, as modified by this section.

If requested, provide the Engineer with two copies of the chemical analysis of reinforcing bars in accordance with the relevant ASTM specifications.

905.03. Bar Reinforcement for Structures

Deformed steel bars used for non-prestressed concrete reinforcement must meet the requirements of ASTM A615/A615M, ASTM A706/A706M, or ASTM A996/A996M (Type A or Type R) for Grade 60 steel bars, unless otherwise required.

Deformed steel bars used for prestressed concrete reinforcement must meet the requirements of ASTM A615/A615M, ASTM A706/A706M, or ASTM A996/A996M (Type A) for Grade 60 steel bars, unless otherwise required.

A. **Bending**. Shop cold bend bar reinforcement to the shapes shown on the plans. Complete all field bending cold. Do not heat bars during bending.

The diameter of a bar bend, measured on the inside of the bar, must meet the requirements of Table 905-1.

Table 905-1:
Minimum Bend Diameters

ASTM Bar Designation No.	Minimum Inside Diameter of Bend (bar diameters)
No. 3 – No. 8	6
No. 9 – No. 11	8
No. 14, No. 18	10
Stirrups and ties, No. 3 – No. 5	4

Cut and bend bars in accordance with the *CRSI Manual of Standard Practice* and the *ACI Detailing Manual*.

B. **Bundling and Tagging.** Ship bar reinforcement in standard bundles, tagged and marked in accordance with the *CRSI Manual of Standard Practice*.

C. **Epoxy Coating.** Epoxy-coated steel reinforcement bars must be coated in accordance with ASTM A775/A775M. Epoxy-coated steel-welded wire reinforcement must be coated in accordance with ASTM A884/A884M, Class A, Type 1. The following exceptions and additions apply:

1. Select coating material from the Qualified Products List.
2. The Department may test samples to verify thickness of coating, adhesion of coating, and holidays. Coat more steel reinforcement than shown on the plans to allow splicing to replace steel reinforcement removed for test samples.
3. Include written certification from the coating applicator that the steel reinforcement was cleaned, coated, and tested in accordance with ASTM A775/A775M (for reinforcing bars) or ASTM A884/A884M (for reinforcing wire).
4. Repair damage to the coating in accordance with subsection 706.03.E.8.

D. **Bar Chairs and Wire Ties for Epoxy-Coated Steel Reinforcement.** Bar chairs and wire ties required for placing and fastening steel reinforcement must conform to the following:

1. Bar chairs must be plastic-coated wire, epoxy-coated wire, or plastic.
2. Wire ties must be plastic-coated wire, epoxy-coated wire, or molded plastic clips.
3. Tie-down wires must be plastic coated.

905.04. Bar Reinforcement for Pavements

Bar reinforcement for pavement tie bars and bars for use as dowels for load transfer in pavement expansion joints and contraction joints must meet the requirements of section 914.

905.05. Dowels and Bar Reinforcement for Curb, Glare Screen, Concrete Barriers, and Filler Walls

Deformed steel bars must meet the requirements of ASTM A615/A615M, ASTM A706/A706M, or ASTM A996/A996M (Type A or Type R) for Grades 40, 50, or 60 as applicable.

905.06. Steel-Welded Wire Reinforcement

Deformed steel-welded wire reinforcement must meet the requirements of ASTM A1064/A1064M and be fabricated as required.

905.07. Strand for Prestressed Concrete

Strands for prestressed concrete must have a 0.500-inch nominal diameter and a 0.153-square-inch cross sectional area or a 0.6000-inch nominal diameter and a 0.217-square-inch cross sectional area and must meet the requirements of ASTM A416/A416M for Grade 270, low relaxation strand, as required.

Identify each reel or pack number and provide a Test Data Certification, including a load elongation curve to at least 1% elongation.

Protect prestress strands from physical damage, rust, and contaminants.

905.08. Tendons for Lateral Post Tensioning of Box Beams

Tendons for lateral post tensioning of box beams must meet the requirements of ASTM A416/A416M for Grade 270 steel strand or ASTM A722/A722M for high-strength steel bars.

If selecting bars, consider the tolerances allowed in manufacturing and placing precast concrete box beams and determine the required bar lengths accordingly.

Section 906. Structural Steel

906.01. General Requirements

Finished rolled shapes must be free from imperfections that affect strength and durability in accordance with ASTM A6/A6M. Rolled shapes must have a smooth and uniform finish. Straighten rolled shapes in the mill if necessary before shipment.

906.02. Testing

Test structural steel materials in accordance with the specified ASTM, AASHTO, or Department methods, as modified by this section.

Mechanically test structural steel products in accordance with ASTM A6/A6M and AASHTO T 244.

906.03. Mill Inspection

Mill inspection is waived unless otherwise specified. If required, the Department will conduct mill inspection in accordance with Division 1, subsection 707.02, and subsection 906.01. Notify the Department before beginning rolling to allow time for inspection. Provide Mill Test Reports in accordance with subsection 707.02.

906.04. Structural Steel

Perform impact testing in accordance with AASHTO M270 and at the temperatures required for Zone 2.

Non-fracture critical main members must meet the tension component impact test requirements at Frequency (H) in accordance with AASHTO T243, regardless of the direction of stress in the member. Main members identified in the contract by the Engineer as fracture critical must meet the fracture critical tension component impact test requirements at Frequency (P) in accordance with AASHTO T243.

The Department considers the average flange thickness to be the governing thickness for wide-flange beams, wide-flange tees, and channel shapes. The Department considers the required leg thickness to be the governing thickness for angles. Take test specimens for these shapes at one-third the distance from the outer edge of the flange or leg to the web or heel.

Fill plates, less than ⅜ inch thick, may be fabricated from steel conforming to ASTM A1011/A1011M or ASTM A606/A606M.

906.05. Foundation Piles

The piling manufacturer must provide a certified mill test report showing the physical properties of the steel.

Foundation piles must meet the following requirements for the type of pile required. If the Engineer determines that the pile cutoffs are in good condition, pile cutoffs that meet size and thickness requirements will be accepted without mill test reports. If submitting pile cutoffs without mill test reports, provide the Engineer with two copies of an affidavit stating that the material provided meets the contract requirements.

A. **Steel H-Piling and Special Sections.** Steel H-piling and special sections must meet the requirements of AASHTO M270, Grades 50 or 50W, or ASTM A690/A690M.

B. **Steel Shells for Cast-in-Place Concrete Piles.** Steel shells for cast-in-place concrete piles must have the nominal outside diameters (ODs) and meet or exceed minimum shell metal thickness shown on the plans. Steel shells must meet the requirements of ASTM A252/A252M Grade 3 welded and seamless steel pipe piles except the yield strength must be a minimum of 50 ksi (Grade 3 Modified). Spiral weld steel shells are allowed.

   If shell thicknesses greater than the minimum stated on the plans are provided to increase strength and rigidity during driving due to the equipment selected or distortion caused by soil pressures from driving adjacent piles when the driving sequence shown on the plans is not followed, the extra costs will be considered as included in the pay item.

   If shell thicknesses greater than the minimum stated on the plans are necessary to obtain proper pile penetration in unforeseen soil properties or distortion caused by soil pressures from driving adjacent piles when the driving sequence as noted on the plans is followed, the extra costs will be paid for as extra work.

   Use watertight pipe shells to exclude water during the placement of concrete.

   Do not use fluted shells.

C. **Pile Points.** Pile points must conform to the dimensions shown on the plans. Provide certification that the steel used for the fabrication of the points meets one of the following:

   1. AASHTO M270 Grade 50 or Grade 50W;
   2. SAE Grade 1016 through Grade 1027; or
   3. SAE Grade 1030.

D. **Pile Protection.** Provide asphalt or ultraviolet-stabilized, extruded, corrugated polypropylene sheets for pile protection. The asphalt must conform to ASTM D449/A449M, Type II. The polypropylene sheets must conform to Table 906-1. The polypropylene sheets must be preformed and scored to fold around and conform to the shape of the piling. The length of each sheet must be at least 4 feet.

Table 906-1:
Polypropylene Sheet Specifications

Property	Specification	Test Method
Specific gravity	0.906	ASTM D1505
Melt flow	0.5 g/10 min	ASTM D1238
Tensile at yield	4,000 psi	ASTM D638
Flexural modulus	195,000 psi	ASTM D790
Elongation at break	>500%	ASTM D638
Heat deflection temperature at 66 psi	190ºF	ASTM D648
Notched Izod at 73°F	No break	ASTM D256
Rockwell hardness	75 R Scale	ASTM D785

906.06. Steel Sheet Piles

For permanent steel sheet piling, the steel piling manufacturer must provide the Department with a certified mill test report that shows the physical properties of the steel.

Sheet piles must meet the following requirements for the type of pile required. If the Engineer determines that the pile cutoffs are in good condition, pile cutoffs that meet the size and thickness requirements will be accepted without mill test reports. If submitting pile cutoffs without mill test reports, provide the Engineer with two copies of an affidavit stating that the material provided meets the contract requirements.

A. **Temporary Steel Sheet Piling.** Temporary steel sheet piling must meet the requirements of AASHTO M202 or AASHTO M270, Grade 36, Grade 50, or Grade 50W.

B. **Permanent Steel Sheet Piling.** Permanent steel sheet piling must meet the requirements of AASHTO M270, Grade 50.

906.07. High-Strength Steel Bolts, Nuts, and Washers for Structural Joints

Structural bolts must meet the requirements of ASTM F3125/F3125M, Grade A325, Type 1. Nuts must meet the requirements of ASTM A563, Grade DH or AASHTO M292, Grade 2H. Washers must meet the requirements of ASTM

F436/F436M for circular, beveled, clipped circular, and clipped beveled washers.

Bolts, nuts, and washers must be hot-dip galvanized in accordance with AASHTO M232. Galvanized nuts must be tapped oversize in accordance with ASTM A563 and meet supplementary requirements S1 and S2.

906.08. Pins and Link Plates for Steel Bridge Construction

Link plates for steel bridge construction must meet the requirements of AASHTO M270, Grade 50 or Grade 50W, and pins must meet the requirements of ASTM A276/A276M UNS designation S21800 or S20161 annealed stainless steel with 50 ksi yield point. Provide washers made from austenitic stainless steel meeting the chemical requirements of ASTM A276/A276M UNS designation S31600, S31603, S21800, or S20161.

The longitudinal Charpy V-notch impact values for pin and link plate materials in redundant structures must meet the requirements for high-strength structural steel in subsection 906.04 and require impact testing at Frequency (P). Use the steel yield point stress value shown in the certified mill test report to determine the testing temperature. The steel may require heat treatment to meet the Charpy V-notch impact requirements.

The longitudinal Charpy V-notch impact values for pin and link plate materials in non-redundant structures must average 30 foot-pounds when tested at the lowest anticipated service temperature (LAST) specified for the MDOT region location of the structure in accordance with Table 906-2.

Table 906-2:
Lowest Anticipated Service Temperatures by MDOT Region

Region	LAST
Superior	−25°F
North	−20°F
Grand and Bay	−15°F
Southwest, University, and Metro	−10°F

906.09. Shear Developers

Select steel shear connectors from the Qualified Products List. Steel shear connectors must be designed for end welding to steel beams and girders with automatically timed stud welding equipment. Provide steel shear connectors as shown on the plans.

Provide an arc shield (ferrule) with each stud. The arc shield must be made of a heat-resistant ceramic or material that will not adversely affect the welds,

cause excessive slag, or crumble or break from thermal or structural shock during welding.

Furnish flux for welding with each connector that is attached to the end of the connector or combined with the arc shield for automatic application in the welding operation.

Steel shear connectors must meet the requirements of AASHTO M169 for cold finished carbon steel, cold drawn bar, Grade 1015 or Grade 1020, either semi-killed or fully killed. If using flux-retaining caps, provide cold-rolled steel caps of a low carbon grade for welding that meet the requirements of ASTM A109/A109M.

Tensile properties, as determined by tests of bar stock after drawing or of finished connectors, must conform to the minimum requirements shown in Table 906-3.

Table 906-3:
Steel Shear Connector Tensile Properties

Property	Specification (minimum)
Tensile strength	60 ksi
Yield strength	50 ksi
Elongation	20% in 2 inches
Reduction of area	50%

Determine tensile properties in accordance with AASHTO T244 for mechanical testing of steel products. Use the 0.2% offset method to determine the yield strength.

Finished connectors must be uniform in quality and condition and free from injurious laps, fins, seams, cracks, twists, bends, or other defects. Use cold drawing, cold rolling, or machining to finish.

Section 907. Fencing Materials

907.01. General Requirements

Materials for fencing property, right-of-way, and other installations must meet the requirements of this section.

907.02. Testing

Fencing materials testing will be in accordance with the specified ASTM, AASHTO, or Department methods, as modified by this section.

The weights of fencing material include the weight of coating unless otherwise specified.

Zinc coating at 1 ounce per square foot corresponds to a coating thickness of 1.7 mils.

907.03. Woven Wire Fence

A. **Fabric.** Steel woven wire fabric must be zinc or aluminum coated.

1. **Zinc Coated.** Zinc-coated fabric must meet the requirements of ASTM A116, Design No. 1047-6-11, for Grade 60, Class 1 zinc coating.

2. **Aluminum Coated.** Aluminum-coated fabric must meet the requirements of ASTM A116, Design No. 1047-6-11.

B. **Barbed Wire.** Standard grade zinc- or aluminum-coated steel barbed wire must be composed of two strands of wire with four-point round barbs. Provide chain-link-fence-grade barbed wire for use with chain link fence.

1. **Zinc Coated.** Zinc-coated barbed wire must meet the requirements of ASTM A121 and the following:

   a. If the direction of the strand wire twist alternates between left and right, the strand wires must not untwist under a tensile force of 950 pounds for 12½-gauge wire, 850 pounds for 13½-gauge wire, or 750 pounds for 15½-gauge wire; and

   b. Class 1 zinc coating is required for 12½-gauge steel wire, and Class 3 zinc coating is required for 13½-gauge wire and 15½-gauge wire.

2. **Aluminum Coated.** Aluminum-coated barbed wire must meet the requirements of ASTM A121 for standard grade aluminum-coated steel barbed wire with aluminum-coated barbs.

C. **Smooth Line Wire.** Smooth line wire must be No. 9 gauge coated steel wire meeting the requirements of ASTM A116, for Grade 60, Class 1

zinc-coated smooth line wire or ASTM A116 for aluminum-coated smooth line wire.

D. **Steel Posts.** After fabrication, galvanize steel fence posts, braces, and fittings in accordance with ASTM A123/A123M and this subsection.

The weight of zinc coating per square foot of surface on posts and braces must average at least 2.00 ounces, and no individual specimen may have less than 1.80 ounces of zinc coating per square foot regardless of metal thickness. The Department will include the weight of zinc coating in the weights specified for posts and braces but will deduct the weight of galvanizing greater than 4.00 ounces per square foot of surface from the post weight.

An alternative zinc and clear coat system for pipe sections is allowed. The exterior surface of the pipe section must have 0.90 ounce per square foot of zinc coating and a clear acrylic coating at least 0.30 mil thick. The interior surface of the pipe section must have 0.35 ounce per square foot of zinc coating or 0.30 mil zinc rich organic coating and a zinc powder loading of at least 91% by weight.

Zinc coating must be applied in accordance with ASTM A123/A123M. Determine coating weights and thicknesses in accordance with AASHTO M181.

1. **Line Posts.** Steel for line posts must meet the requirements of ASTM A702 for Type A or Type B. Line posts must be 7 feet long, ±1 inch, with a nominal weight of 1.12 pounds per foot. Exclusive of the anchor plate, individual line posts must weigh 1.08 pounds per foot. Posts must be notched, studded, or have other Department-approved means of holding the fabric in place on the post. Provide each post with a Department-approved anchor plate and at least seven 11-gauge galvanized or aluminum-coated wire clamps.

2. **End, Corner, Gate, Intersection, and Intermediate Braced Posts**. Steel angle sections, steel pipe, or steel tubing end, corner, gate, intersection, and intermediate braced posts must have an average weight within 10% of the specified weight per foot. Angle sections for posts and braces must meet the physical requirements of ASTM A36/A36M or ASTM A702 for Type A or Type B.

   Provide the required fittings and braces with each post.

   a. **Posts.** End, corner, gate, intersection, and intermediate braced posts must be 8 feet long, ±1 inch.

Angle sections must be nominal 2½ inch by 2½ inch by ¼ inch. Pipe or tubing must be nominal 2 inch (2.375 inch OD) weighing 3.650 pounds per foot.

b. **Braces.** Angle section braces must be nominal 1¾ inch by 1¾ inch by ¼ inch or nominal 2 inch by 2 inch by $^{3}/_{16}$ inch. Steel pipe braces must be nominal 1½ inch (1.900 inch OD) weighing 2.72 pounds per foot. Steel tubing braces must be nominal 1.750 inch OD weighing 3.13 pounds per foot.

Braces must be long enough to support the posts.

E. **Wood Posts.** Wood posts must meet the requirements of subsection 912.07.

F. **Gates.** Provide gates for woven wire fence of the width and height shown on the plans. Provide each gate with Department-approved hinges, latches, and auxiliary braces to prevent sagging. Weld or fit to form a rigid and watertight frame. Use woven wire in accordance with subsection 907.03.A to fill gate frames.

907.04. Steel Chain Link Fence

A. **Fabric.** Chain link fence fabric must be zinc-coated steel fabric meeting the requirements of ASTM A392 for Class 2 coating, aluminum-coated steel fabric, meeting the requirements of ASTM A491 or polymer-coated steel fabric meeting the requirements of ASTM F668 as modified by this subsection.

Galvanize zinc-coated fabric after weaving.

Polymer-coated steel chain link fence fabric must meet ASTM F668, Class 2a, except that the steel core wire may be either hot-dip zinc coated (galvanized) or aluminum coated (aluminized) prior to polymer coating. Both the metallic coating and the polymer coating must be applied before weaving. The minimum weight of metallic coating must conform to ASTM F668, Class 2a, for zinc galvanized or ASTM A817 for aluminum. Provide fabric height and polymer coating color as shown on the plans.

Provide steel chain link fence fabric with the following characteristics:

1. Mesh size of 2.0 inches or as shown on the plans;
2. Wire size of 9-gauge zinc coated, 9-gauge aluminum coated, or 10-gauge aluminum coated; and
3. Top and bottom selvages knuckled.

B. **Tension Wire.** Tension wire must meet the steel wire requirements of ASTM A824 for Type I aluminum coating and Type II, Class 3, zinc coating.

As an alternative to tension wire coatings, the Contractor may use hot-dip Type I aluminized or hot-dip Type II, Class 1 galvanized, followed by a polymer coating. The polymer coating must meet the requirements for polymer-coated steel chain link fence fabric and match the color of the polymer-coated steel chain link fence fabric.

C. **Posts for Fence and Gates.** Fence posts and gate posts for chain link fence must be metallic-coated steel meeting the requirements of Table 907-1 and Table 907-2.

Table 907-1:
Posts and Rail for Steel Chain Link Fence

Use	Fabric Height (inch)	Diameter[a] (inch)	Nominal Weight (lb/ft)	ASTM Steel Specification[b]
End, corner, angle, and intermediate braced posts[c]	≤120	2½ (2.875)	5.80	F1083
		2½ (2.875)	4.64	F1043
		3½ by 3½ RF corner[d]	5.10	F1043
Line posts	≤120	2 (2.375)	3.65	F1083
		2 (2.375)	3.12	F1043
		1⅞ by 1⅝ H-section	2.72	F1043
		2¼ by 1 45/64 H-section	3.26	F1043
		2¼ by 1⅝ C-section[c]	2.70	F1043
	≤72	2 (2.375)	2.31	F1043
		1⅞ by 1⅝ C-section[c]	2.26	F1043
	≤60	1½ (1.900)	2.72	F1083
			2.28	F1043
Horizontal rail	—	1¼ (1.660)	2.27	F1083
		1¼ (1.660)	1.84	F1043

(a) Outside pipe diameter with nominal diameter given first; actual diameter in parentheses.

(b) ASTM F1083 references are for standard weight (Schedule 40) pipe.

(c) Posts for fencing on structures must be 2½ inch (2.875 inch) nominal outside pipe diameter and must meet the requirements of ASTM F1083 (Schedule 40) or ASTM F1043 (Group 1C) or as called for on the plans.

(d) RF: roll-formed sections

Table 907-2:
Pipe for Gate Posts and Frames

Use	Gate Width (feet)	Diameter[(a)] (inch)	Nominal Weight (lb/ft)	ASTM Steel Specification[(b)]
Gate posts	≤6	2½ (2.875)	5.80	F1083
		2½ (2.875)	4.64	F1043
	7–13	3½ (4.000)	9.11	F1083
		3½ (4.000)	7.65	F1043
	14–18	6 (6.625)	18.97	F1083
Gate frames	≤6	1¼ (1.660)	2.27	F1083
		1¼ (1.660)	1.40	F1043
	7–18	1½ (1.900)	2.72	F1083
		1½ (1.900)	2.28	F1043

(a) Outside pipe diameter with nominal diameter given first; actual diameter in parentheses.

(b) ASTM F1083 references are for standard weight (Schedule 40) pipe.

The average weight per foot of metallic-coated fence posts must be within 10% of the required weight per foot. Posts must be at least 32 inches longer than the height of the fence fabric.

Steel posts for chain link fence must be coated with zinc or aluminum inside and outside or polymer-coated posts in accordance with one of the following methods:

1. **Zinc Coating**. Apply zinc coating meeting the requirements of ASTM A123/A123M or ASTM A653/A653M. Use the alternative zinc and clear coat system described in subsection 907.03.D for pipe sections only.

   The weight of zinc coating on pipe sections must average at least 1.80 ounces per square foot of surface and at least 1.60 ounces per square foot of surface per specimen when tested in accordance with ASTM A90/A90M.

   For posts, other than pipe sections, the weight of zinc coating on each post must average at least 2.00 ounces per square foot of surface and at least 1.80 ounces per square foot of surface per specimen when tested in accordance with ASTM A90/A90M.

2. **Aluminum Coating.** Use Type 2 aluminum to coat posts. The weight of aluminum coating on each post must average at least 0.75 ounces per square foot of surface and at least 0.70 ounces per square foot of surface per specimen when tested in accordance with ASTM A428/A428M.

3. **Polymer Coating.** After metallic coating, coat exterior surfaces with extruded and adhered polymer coating. Match the color of the post to the color of the polymer-coated steel chain link fence fabric coating.

D. **Gates.** Provide gates for chain link fence as shown on the plans. Provide metallic-coated steel pipe gate frames in accordance with Table 907-2. The average weight per foot of the pipe for the gate frames must be within 10% of the required weight per foot. Use the same type and weight of coating required for posts.

Weld or fasten joints to form a rigid and watertight frame. Wire brush welded joints and paint with two coats of a Department-approved zinc-rich paint.

Provide gates with intermediate braces and truss rods to prevent sagging, and provide Department-approved hinges, latches, keepers, and stops. Fill the gate frames with fabric meeting the same requirements as for the fence fabric.

Provide polymer-coated gate frames the same as for metallic-coated gate frames in accordance with Table 907-2. Apply polymer coating to gate frames including hinges, latches, keepers, and stops. Match the color of the polymer-coated gate frame to the color of polymer-coated steel chain link fence fabric.

E. **Fence Fittings and Hardware.** Provide post caps, rail, or brace ends; tie wires and clips; tension and brace bands; tension bars; truss rods; barb arms; and other hardware meeting the requirements of ASTM F626 and the exceptions and additions specified in this subsection.

Bevel the ends of hog rings for fastening fabric to the tension wire to allow crimping.

Provide fittings made of malleable iron or pressed steel for fences and gates.

If using aluminum-coated wire ties and clips, ensure that the coating weighs at least 0.30 ounces per square foot of surface.

The Contractor may use flat aluminum alloy line post bands with an OD from 0.062 to 0.375 inch and with self-locking ends to fasten fabric to posts with an OD no greater than 2.375 inches.

Use double twisted, No. 9 gauge, galvanized steel for fabric fasteners for structure fencing.

Polymer-coated fence fittings and hardware must be as specified above. After metallic coating, coat exterior surfaces with extruded and adhered

polymer coating. Ensure that the color of the polymer coating matches the color of the polymer-coated steel chain link fence fabric.

907.05. High-Tensile Wire Fence

A. **Wire.** High tensile wire must be 1½ gauge, Grade 200, with Class 3 zinc coating in accordance with ASTM A854/A854M.

B. **Wood Posts.** Wood posts must be pressure treated and meet the requirements of subsection 912.07.

C. **Hardware.** Galvanize hardware in accordance with ASTM A153/A153M.

907.06. Protective Fencing

Protective fencing must be orange, high-density polyethylene (HDPE) mesh fabric with a nominal 2-inch diamond design. Protective fencing must be 48 inches high and weigh at least 0.102 pound per square foot.

Section 908. Miscellaneous Metal Products

908.01. General Requirements

Miscellaneous metal products must meet the requirements of this section and the contract.

908.02. Testing

Miscellaneous metals product testing will be in accordance with the specified ASTM, AASHTO, or Department methods, as modified by this section.

908.03. Malleable Iron Castings

Malleable iron castings must meet the requirements of ASTM A47/A47M for Grade 22010.

908.04. Steel Castings

Steel castings for steel construction must meet the requirements of ASTM A148/A148M for Grade 90-60 carbon steel castings, as shown on the plans, unless otherwise approved by the Engineer. Steel castings must be heat treated by full annealing, unless otherwise required.

Blow holes on finished castings must be located so that a straight line laid in any direction will not cut a total length of cavity greater than 1 inch in any 12 inches. Single blow holes must not exceed 0.500 square inch or have a depth that will affect the strength of the casting.

908.05. Iron Castings

Gray iron castings must meet the requirements of AASHTO M306, Class 35B, for manholes, catch basins, leaching basins, inlets, iron steps, and bridge deck drains. Ductile iron castings meeting the requirements of AASHTO M306, Grade 70-50-05 or Grade 80-55-06, are an acceptable alternative to gray iron when shown on the plans. Castings must be certified to proof load testing of 50,000 pounds. Coat exposed casting surfaces with asphaltic paint. The coating must be smooth, tough, and tenacious when cold and must not scale-off, tack, or become brittle.

908.06. Bronze or Copper-Alloys for Structures

Washers, bearing, and expansion plates for bridges must meet the requirements of ASTM B22/B22M for Copper Alloy UNS No. C91100 bronze castings or the requirements of ASTM B100 for Copper Alloy UNS No. C51000 copper alloy plates and sheets. Provide bronze castings that are free of deleterious material, casting faults, injurious blow holes, and other defects.

Finished parts must be within 5% of the required thickness and within 0.125 inch of the required width and length shown on the plans. Mating curved surfaces must have a curvature radius no greater than +0.010 inch on concave surfaces and no less than −0.010 inch on convex surfaces shown on the plans. Flat machined surfaces must meet the required dimensions within 0.0005 inch per 1.0 inch.

The surface roughness of bronze or steel must not be greater than 125 micro inches per inch root mean square.

908.07. Sheet Lead

Sheet lead must meet the requirements of ASTM B29 for desilverized pig lead.

908.08. Sheet Copper

Sheet copper must meet the requirements of ASTM B370.

908.09. Tubing, Steel Railings

A. **Base Plates, Angles, and Post Elements.** Base plate, angle, rail splice, and non-tubular post elements must meet the material requirements of ASTM A36/A36M and galvanizing requirements of ASTM A123/A123M. Tubular post elements must meet the material requirements of ASTM A500/A500M, Grade B, and galvanizing requirements of ASTM A123/A123M. Silicon content must be less than 0.06% or from 0.15 to 0.25%. Base plate and post elements must meet the Charpy V-notch impact requirements specified in subsection 906.04.A at a test temperature of 10°F.

B. **Rail Elements.** Rail elements must meet the material requirements of ASTM A500/A500M, Grade B, and galvanizing requirements of ASTM A123/A123M. Silicon content must be less than 0.06% or from 0.15 to 0.25%.

Provide the Engineer with one copy of the Mill Test Report (MTR) verifying chemical and physical requirements for structural steel rail elements. Provide an affidavit stating that the material meets specifications. If the MTR is unavailable, arrange for tests of chemical and physical properties and provide certified copies of the test reports and affidavits to the Engineer at no additional cost to the Department. The Contractor has the option of re-testing a rail sample if it failed elongation and passed all other chemical and physical requirements.

The Contractor must drop-weight tear test rail elements from all heats supplied in accordance with ASTM E436 except as modified herein. Drop-weight tear testing is not required on hollow structural section (HSS)

2 by 2 rail elements. Do not heat treat failed heats and do not provide failed heats to the fabricator. The Contractor must conduct the drop-weight tear test on each heat at 0°F on 2- by 9-inch specimens, supported to achieve a 7-inch span.

The Contractor must test three specimens from each of three sides that do not contain a weld to determine the percent shear area. The Contractor must disregard the shear areas of the three specimens from the side with the lowest average shear area and base the final average on the remaining six specimens. Material with an average percent shear area below 50% is not allowed; however, if the average percent shear area is between 30 and 50%, the Department will allow the Contractor to retest the material. The retest sampling frequency is three times that of the first test, and all sample test results must be included in calculating the average. Retested material must have a minimum average percent shear area of 50%.

The manufacturer of the tubular railing must identify the product as follows:

1. Place identification before galvanizing;
2. Include heat number or other code traceable to the heat number;
3. Include manufacturer's unique identification code;
4. Place identification on only one section face;
5. Repeat identification at no more than 4-foot intervals;
6. Do not extend identification into the curved surfaces at corners of section; and
7. Do not place identification on side facing traffic or side opposite traffic.

C. **Hardware.** Railing anchor studs must meet the requirements of ASTM A449, Type 1. Structural bolts must meet the requirements of ASTM F3125/F3125M, Grade A325, Type 1. Round head structural bolts must meet the requirements of ASTM A449, Type 1. The material for the railing hand hole screws must meet the requirements of ASTM A276/A276M, Type 304. Nuts must meet the requirements of ASTM A563, Grade DH, or AASHTO M292, Grade 2H. Flat, circular washers must meet the requirements of ASTM F436/F436M. Lock washers must be steel, regular, helical spring washers meeting the requirements of ASME B18.21.1.

Bolts, anchor studs, nuts, and washers must be hot-dip galvanized in accordance with AASHTO M232. Galvanized nuts must be tapped oversize in accordance with ASTM A563 and meet supplementary requirements S1 and S2.

908.10. Hardware for Timber Construction

Machine bolts, drift bolts, and dowels for timber construction must be made of structural grade steel.

Washers must be cast iron ogee or malleable castings. Nails must be cut or round wire of standard form. Spikes must be cut or wire spikes or boat spikes. Galvanize in accordance with AASHTO M232 when required.

908.11. Steel Beam Guardrail Elements, Hardware, and Steel Sleeves

A. **Steel Beam Elements and End Sections.** Unless otherwise specified on the plans and details, provide steel beam elements and terminal end shoes meeting the requirements of AASHTO M180 for Class A guardrail. Thrie beam elements for bridge rail retrofit, special end shoes, and thrie beam terminal connectors must meet the requirements of AASHTO M180 for Class B guardrail.

Provide steel beam elements and end sections in the required shape. Steel beam elements and end sections must be hot-dip zinc coated after fabrication in accordance with AASHTO M180 for Type II zinc coatings. W-beam elements may be hot-dip zinc coated before or after fabrication.

B. **Hardware.** Bolts, nuts, washers, and other guardrail hardware must be hot-dip galvanized in accordance with AASHTO M232.

Bolts must meet the requirements of ASTM A307, Grade A. Nuts must meet the requirements of ASTM A563, Grade A with supplementary requirement S1. Flat circular washers must meet the requirements of ASTM F436/F436M.

Beveled square or rectangular washers must meet the requirements of ASTM F436/F436M and the dimensions shown on the plans.

Bolts and nuts for making splices and connections of beam elements, other than at bridge barrier railings, must meet the requirements of AASHTO M180. Provide bolts meeting one of the bolt head configurations of AASHTO M180 (Alternate No. 1 or 2) except within the limits of guardrail approach terminals. Hardware for guardrail approach terminals must conform to manufacturer’s specifications.

Structural bolts for connections at bridge railings must conform to ASTM F3125/F3125M, Grade A325, Type 1. Nuts must meet the requirements of ASTM A563, Grade DH, or ASTM A194/A194M, Grade 2H. Flat circular washers must meet the requirements of ASTM F436/F436M.

Wire rope and fittings for the cable anchorage must conform to AASHTO M30. Wire rope must be Type II with a Class B coating.

C. **Steel Sleeves, Soil Plates, and Bearing Plates.** Provide steel sleeves with the inside dimensions shown on the plans within a tolerance, after galvanizing, of +⅛ inch. Provide steel plates in the sizes shown on the plans but no more than 0.250 inch larger.

Steel for the sleeves and plates for wood guardrail posts must meet the requirements of ASTM A36/A36M or ASTM A1011/A1011M for Grade 36 or Grade 40.

Steel sleeves must have one or two complete penetration longitudinal welds that run along the length of the sleeve.

Hot-dip galvanize sleeves and plates in accordance with AASHTO M111. The weight of the zinc coating on the sleeves must average at least 2.0 ounces per square foot and each sleeve must have at least 1.7 ounces of zinc coating per square foot. The weight of the zinc coating on plates must average at least 2.3 ounces per square foot, and each plate must have at least 2.0 ounces of zinc coating per square foot.

908.12. Steel Posts for Guardrail

Steel posts for guardrail must be W6 by 9 or W6 by 8.5 section steel posts of the length shown on the plans for guardrail. Each steel post must weigh at least 9.0 pounds per foot. Posts must be fabricated from ASTM A36/A36M structural steel.

Hot-dip galvanize posts in accordance with AASHTO M111 to produce an average coating weight of at least 2.0 ounces per square foot of surface area.

908.13. Guardrail Reflectors

Fabricate guardrail reflectors from at least 13-gauge steel sheets, galvanized in accordance with ASTM A653/A653M, coating designation G210, and as required. Use Type XI reflective sheeting meeting the requirements of subsection 919.03.B.

Prepare galvanized surfaces in accordance with the sheeting manufacturer's recommendations before applying the sheeting. Bond reflective material to the galvanized steel.

908.14. Anchor Bolts, Nuts, and Washers

A. **General.** The fabricator or supplier must provide a Mill Test Report (MTR) that shows compliance with ASTM F1554 for the grade specified in the contract in addition to the following:

1. Heat number;
2. Yield strength;

3. Tensile strength;
4. Elongation;
5. Reduction of area; and
6. Charpy V-notch.

Provide the furnace lot number for all heat-treated anchor bolts. Order additional bolts to replace those used for Department testing. Each anchor bolt must be provided with two washers and two nuts unless otherwise required in the contract.

Provide bolts, nuts, and washers in the size and shape shown on the plans and hot-dip galvanized in accordance with AASHTO M232. Galvanize the exposed threaded end of anchor bolts a minimum of 20 inches.

Nuts must meet the requirements of ASTM A563, Grade DH, or ASTM A194/A194M, Grade 2H. Lubricate nuts in accordance with ASTM A563, supplementary requirement S1 and S2. Re-tap nuts after galvanizing in accordance with ASTM A563. Provide flat, circular washers meeting the requirements of ASTM F436/F436M.

B. **Anchor Bolts and Nuts for Cantilever and Truss Sign Supports, Light Standards, Dynamic Message Sign, CCTV Poles, Tower Lighting Units, and Traffic Signals Mast Signal Arm Poles.** Steel anchor bolts must meet the requirements of subsection 908.14.A except that anchor bolt material must meet ASTM F1554, Grade 55, supplemental requirements S1, S3, and S4.

Table 908-1:
Anchor Bolt Specifications

Characteristic	Specification
Yield strength	55 ksi
Ultimate strength	75–95 ksi
Elongation (2-inch gauge)	≥21%[(a)]
Reduction in area	≥30%[(b)]
Longitudinal Charpy V-notch	≥15 ft-lb at 40°F

(a) Elongation (8-inch gauge), minimum 18% for bolts tested full section

(b) Bolts >2 to 2.5 inches, 22% minimum; >2.5 to 3 inches, 20% minimum

The Department will perform Charpy V-notch toughness tests on specimens in accordance with frequency (P) testing of AASHTO T243 orienting the notch perpendicular to the longitudinal axis of the anchor

bolt. If necessary, heat treat steel to meet Charpy V-notch toughness requirements.

Bolt threads must meet the requirements of ASME B1.1, 8UN series, Class 2A tolerances, before coating. After coating, the maximum limit of pitch and major diameter for bolts with a diameter no greater than 1 inch may exceed the Class 2A limit by no more than 0.021 inch and by no greater than 0.031 inch for bolts greater than 1 inch in diameter.

Nut threads must meet the requirements of ASME B1.1, 8UN series, Class 2B tolerances. Tap nuts for anchor bolts less than 1 inch in diameter no greater than 0.021 inch and nuts for anchor bolts equal to or greater than 1 inch in diameter no greater than 0.031 inch.

C. **Anchor Bolts for Traffic Signal Strain Poles.** Provide anchor bolts that meet subsection 908.14.A with the following exceptions and additions:

1. ASTM F1554, Grade 105, supplementary requirement S3;
2. Coarse pitch threads are acceptable if the anchor bolts meet required tolerances;
3. Bolts must be threaded at least 9 inches at the upper end; and
4. Each anchor bolt must be provided with one steel lock washer meeting the requirements of ASME B18.21.1.

D. **Anchor Bolts for Other Purposes.** Steel anchor bolts must meet subsection 908.14.A except that anchor bolt material must meet ASTM F1554, Grade 36, supplementary requirements.

Section 909. Drainage Products

909.01. General Requirements

Use the pipe materials shown in Table 401-1 and Table 402-1 for culverts or sewers if only the size and class are specified by the contract. Construct drainage structures and underdrains as required.

Provide galvanized corrugated steel or aluminum structural plates as required. Galvanized corrugated steel structural plates must meet the requirements of AASHTO M167M/M167. Corrugated aluminum structural plates must meet the requirements of ASTM B790/B790M or Section 12 of the *AASHTO LRFD [Load and Resistance Factor Design] Bridge Specifications*.

Provide sanitary sewer or industrial waste systems in accordance with the contract. Install sanitary sewer or industrial waste systems using a compression gasket as specified in subsection 909.03.

909.02. Testing

Test drainage products in accordance with AASHTO or ASTM specifications unless otherwise specified in this section.

Verify that each concrete pipe manufacturer provides a calibrated standard testing machine to determine the strength of the product. The manufacturer must provide labor and materials to perform strength tests.

909.03. Watertight Joints for Sewers and Culverts

Provide watertight joint systems selected from the Qualified Products List. Ensure that watertight joint systems meet the pressure test requirements of MTM 723 and the specifications for the materials used in assembling the pipe system.

Use flexible rubber compression gaskets meeting the requirements of ASTM C443 for concrete pipe, ASTM F477 for plastic pipe, AASHTO M36 for corrugated metal pipe, and AASHTO M196 for corrugated aluminum pipe. As an alternative to the AASHTO M36 requirements for metal pipe, the Contractor may use gasket material meeting the low temperature flexibility and elevated temperature flow test requirements of ASTM C990, excluding the requirements for softening point, flash point, and fire point.

External rubber gaskets, mastic, and protective film must meet the requirements of ASTM C877 or C990.

909.04. Concrete Pipe Products

A. **Reinforced Concrete Circular Pipe.** Provide reinforced concrete circular pipe meeting the requirements of AASHTO M170 or AASHTO M242. If using AASHTO M242 pipe, the design loads must meet the requirements of AASHTO M170.

If using AASHTO M170 pipe, apply the following exceptions and additions:

1. The Contractor may use the circular pipe designs specified in Table 909-1, Table 909-2, Table 909-3, and Table 909-4 in addition to the circular pipe designs in Table 2, Table 3, Table 4, and Table 5 of AASHTO M170.
2. Cast or drill lift holes and seal with concrete plugs after installing the pipe. Cast lift holes in circular pipe with elliptical reinforcing along the top centerline of the pipe.
3. Use circular reinforcement in circular pipe for use in pipe culverts and sewers jacked in place. The concrete absorption test requirements will be waived if the load required to produce the 0.01-inch crack exceeds the minimum load by at least 20%.

If using stirrup supports, use indentations or waterproof paint to mark the top and bottom centerline of the pipe, inside and out, on each end of the pipe. Symmetrically place stirrup supports around the centerline in the top and bottom portion of the pipe. Pass stirrups around and in contact with each inside circumferential reinforcing member. Space the stirrups in accordance with Table 909-2, Table 909-3, and Table 909-4. Do not use more than three sections of stirrup material in one support line. Ensure a section length of at least 30 inches for each stirrup.

B. **Reinforced Concrete Elliptical Pipe.** Provide reinforced concrete elliptical pipe meeting the requirements of AASHTO M207. The concrete absorption test requirement will be waived if the load required to produce the 0.01-inch crack exceeds the required minimum load by at least 20%.

The Contractor may use the horizontal elliptical pipe designs specified in Table 909-5 and Table 1 of AASHTO M207.

C. **Non-Reinforced Concrete Pipe.** Provide non-reinforced concrete pipe meeting the requirements of AASHTO M86. Place required markings on the barrel of the pipe near the socket. Ensure that the markings remain legible during delivery of the pipe to the project.

D. **Precast Concrete Box Sections.** Use precast concrete box sections as required and in accordance with ASTM C1577.

E. **Concrete End Sections.** Provide precast concrete end sections fabricated using material meeting the requirements of AASHTO M170 for Class II and as shown on the plans. Provide wet-cast concrete for end sections with an entrained air content of 5.5 to 8.5%. When using the dry cast process, use at least 658 pounds of cement per cubic yard of concrete and use a liquid air-entraining agent at the dosage recommended by the manufacturer for dry cast concrete.

Use tongue and groove joints to make connections to pipe culverts.

F. **Pipe Culverts Jacked in Place.** For pipe culverts jacked in place, use reinforced concrete pipe at least 36 inches in diameter, meeting the requirements of AASHTO M170 for Class V, Wall B or C, with full circular reinforcing.

G. **Precast Concrete Three-Sided and Arch Sections.** Use precast concrete three-sided and arch sections as required and in accordance with ASTM C1504.

909.05. Metal Pipe Products

For metal pipe products, refer to Table 909-6 for the minimum wall thickness, or refer to Table 909-7 through Table 909-17, and Table 909-20 to determine the required wall thickness.

Refer to Table 909-19 for gauge equivalents for specified nominal thicknesses.

A. **Corrugated Steel Pipe.** Provide circular and pipe arch corrugated steel pipe meeting the requirements of AASHTO M36 for metallic-coated pipe. For polymer-precoated pipe, provide circular and pipe arch corrugated steel pipe meeting the requirements of AASHTO M245 and using an ethylene acrylic acid film selected from the Qualified Products List.

The Contractor may use Type IA and Type IIA dual-wall polymer-precoated galvanized corrugated steel pipe of the wall thicknesses specified in Table 909-20 and specified in subsection 909.05.

1. **Steel Sheet**. Provide corrugated steel pipe from zinc-coated sheets meeting the requirements of AASHTO M218 or from aluminum-coated sheets meeting the requirements of AASHTO M274.

On zinc-coated steel sheet for polymer-precoated corrugated steel pipe, use ethylene acrylic acid film selected from the Qualified Products List meeting the requirements of AASHTO M246 for Grade 250/250 polymer. Use only lock seam pipe.

Verify that the metallic coating weight on individual samples of fabricated pipe or steel sheet meets the single spot and triple spot test

requirements in accordance with AASHTO M218. Refer to Table 909-6, Table 909-7, Table 909-8, Table 909-9, Table 909-10, Table 909-11, and 909-20 for the specified nominal sheet thickness for a given diameter, class, and size of corrugation of culvert or sewer pipe.

Provide pipe less than 12 inches in diameter, fabricated from steel sheet with a minimum thickness of at least 0.064 inch (16 gauge).

2. **End Finish for Helical Corrugated Pipe.** For helical corrugated pipe, except perforated pipe, with diameters of at least 12 inches, reroll the pipe ends to form at least two circumferential corrugations in accordance with AASHTO M36 or AASHTO M245. This end treatment for perforated pipe and pipe with diameters less than 12 inches and pipe that spans the road surface in a single section is optional for the fabricator.

3. **Coupling Bands**. To connect sections of pipe and to attach end sections to culvert pipe with diameters of at least 12 inches, except perforated pipe, provide coupling bands circumferentially corrugated with the same size corrugations as on the ends of the pipe or use universal bands with gaskets.

   For coupling bands with diameters no greater than 10 inches, use coupling bands with corrugations matching the pipe corrugations.

   The Contractor may connect perforated pipe with a diameter no greater than 12 inches with smooth sleeve-type couplers. For perforated pipe with diameters greater than 12 inches, use coupling bands with corrugations matching the pipe corrugations, dimple bands, or universal bands.

   Provide coupling band connections as specified in subsection 401.03 and meeting the requirements of AASHTO M36 or AASHTO M245.

B. **Corrugated Aluminum Alloy Pipe.** Provide corrugated aluminum alloy pipe meeting the requirements of AASHTO M196, except fabricate pipe from aluminum sheet with the nominal thickness specified in Table 909-12, Table 909-13, Table 909-14, Table 909-15, Table 909-16, and Table 909-17.

   Only use Type IA and Type IIA corrugated aluminum alloy pipe if directed by the Engineer.

C. **Steel End Sections.** Provide steel end sections with coupling bands or hardware as shown on the plans. Metallic coating on the end sections must be the same as the metallic coating on the pipe, except zinc-coated steel end sections may be used with aluminum-coated steel pipe and

polymer-coated steel pipe. Provide metal end sections meeting the requirements of AASHTO M36.

D. **Steel Pipe for Jacking in Place.** Provide steel pipe for jacking in place meeting the requirements of ASTM A53/A53M for Type E or Type S, Grade B, or ASTM A139/A136M for Grade B. Provide a continuous welded joint to create a watertight casing that is capable of withstanding handling and installation stresses. Perform field welding using the shielded metal arc welding process and using E6011 or E7018 electrodes.

909.06. Plastic Pipe Products

Provide smooth-lined corrugated polyethylene (CPE) pipe and required fittings meeting the requirements of AASHTO M294 for Type S.

Provide corrugated polyvinyl chloride (CPV) pipe and required fittings meeting the requirements of AASHTO M304. The Engineer will test CPV pipe in accordance with MTM 728.

If providing a separate fitting or coupling to ensure a watertight joint in corrugated plastic pipe culverts and sewers, use non-corrugated, solid sleeve, fabricated from polyethylene (PE), or polyvinyl chloride (PVC) with a gasket meeting the requirements of subsection 909.03 on both sides of the joint. Do not use split collar couplers.

Provide a pipe indentation in each sleeve in the center to ensure positioning of the pipe sections in the field. Factory-installed sleeves on one end of the pipe sections and place a removable protective material over the exposed gaskets. Lubricate gaskets and sleeves before insertion according to manufacturer's recommendations.

909.07. Pipe for Underdrains

A. **Smooth Plastic Pipe for Underdrain.** Provide smooth plastic pipe for underdrain, fabricated from PVC pipe meeting the requirements of AASHTO M278. For pipes no greater than 6 inches in diameter, the Contractor may use acrylonitrile-butadiene-styrene (ABS) pipe meeting the requirements of ASTM D2751 for SDR 35 with perforations meeting the requirements of AASHTO M278, except that the joint tightness requirements do not apply.

B. **Corrugated Plastic Tubing for Underdrain.** Provide corrugated plastic tubing for underdrain meeting the requirements of AASHTO M252 for PE tubing or ASTM F949 for PVC tubing. Ensure that the perforations for PE and PVC tubing meet the requirements of AASHTO M252.

C. **Underdrain Outlets.** Provide PVC pipe underdrain outlets meeting one of the following requirements:

1. ASTM D1785 Schedule 40;
2. ASTM D2665;
3. ASTM D3034, for Type SDR 23.5; or
4. Corrugated steel pipe in accordance with subsection 909.05.A.

D. **Connections.** Seal connections with tape recommended by the manufacturer for underground service conditions. Provide tape resistant to moisture and organic growth.

909.08. Pipe for Downspouts

A. **Bridge Deck Downspouts.** Provide bridge deck downspouts of PE pipe meeting the requirements of ASTM F714, PE 4710, DR 26, Schedule 80 PVC. The Contractor may provide bridge deck downspouts of fiberglass-reinforced thermosetting resin pipe with a short-term rupture hoops tensile stress of at least 30,000 psi in accordance with ASTM D2996. PVC pipe must be in accordance with ASTM D1785 and ASTM D4216 to prevent changes in color, physical properties, and appearance due to weathering.

B. **Culvert, Downspouts.** If shown on the plans, provide other culvert downspouts made from one of the following:

1. Corrugated steel pipe as specified in subsection 909.05.A;
2. Corrugated aluminum alloy pipe as specified in subsection 909.05.B; or
3. CPE pipe meeting the requirements of AASHTO M294 for Type C.

Provide fittings required for CPE pipe meeting the requirements of AASHTO M294.

Seal joints between lengths of pipe, as recommended by the pipe manufacturer, to form silt-tight joints. Provide end sections as shown on the plans and specified in subsection 909.04.D or subsection 909.05.C.

C. **Bridge Deck Drain Extensions.** Provide bridge deck drain extensions as an integral component of the drain casting assembly in accordance with *MDOT Standard Plan B-101* series.

909.09. Cold-Applied Pipe Joint Sealer

Provide asphaltic material for sealing joints in concrete or clay pipe that can be spread on the joints with a trowel at an air temperature from 14 to 100°F.

The material must not flow, crack, or become brittle if exposed to the atmosphere. Verify that the material adheres to the concrete or clay to make a watertight seal.

Deliver the sealer to the project in sealed containers. Protect the sealer from contamination. Mark the container with “Cold Applied Pipe Joint Sealer” and the brand name, net volume or weight, and application requirements.

909.10. Drainage Marker Posts

Provide drainage marker posts meeting the requirements for plastic or steel delineator posts as specified in section 919 or the requirements for steel line fence posts in section 907, except provide posts at least 6 feet long. The Contractor may submit alternative post materials to the Engineer for approval.

909.11. Rodent Screens

Provide rodent screens of hardware cloth meeting the requirements of ASTM A740 with an opening size no greater than 0.30 inch, except provide wire of a nominal size of 0.057 inch and a minimum zinc coating weight of 0.59 ounce per square foot of uncoated wire surface, applied after weaving. The Contractor may substitute fabric made of Type 304 stainless steel wire with an opening no greater than 0.30 inch and a 0.057-inch nominal wire diameter. The Contractor may submit other screens with openings no greater than 0.30 inch to the Engineer for approval.

Form the screen using a punch and die. After shaping, ensure that the fabric forms a cylinder slightly larger than the inside diameter of the outlet pipe.

Table 909-1:
Additional Designs For Class II Reinforced Concrete Pipe
(AASHTO M170 Table 2 Extended)

Internal Diameter of Pipe (inch)	Minimum Wall Thickness (inch)	Reinforcement per Foot of Pipe Wall (sq in)			
		Circular Reinforcement in Circular Pipe		Elliptical Reinforcement in Circular Pipe	
		Inner Cage	Outer Cage	Inner Circular Cage	Elliptical Cage
114	9.5	0.56	0.34	0.22	0.34
120	10	0.61	0.37	0.24	0.37
126	10.5	0.65	0.39	0.26	0.39
132	11	0.70	0.42	0.28	0.42
144	12	0.80	0.48	0.32	0.48

Notes:
D-load = pound-force per linear foot per foot of diameter
D-load to produce a 0.01-inch crack: 1,000
D-load to produce the ultimate load: 1,500
Concrete strength: 5,000 psi

Table 909-2:
Additional Designs for Class III Reinforced Concrete Pipe (AASHTO M170 Table 3 Extended)

Internal Diameter of Pipe (inch)	Minimum Wall Thickness (inch)	Reinforcement per foot of Pipe Wall (sq in)				Stirrup Support System					
		Circular Reinforcement in Circular Pipe		Elliptical Reinforcement in Circular Pipe							
		Inner Cage	Outer Cage	Inner Circular Cage	Elliptical Cage	Minimum Area per Support Element, (sq in)[a]	No. of Lines[b]	Long. Spacing (inch)	Circum. Spacing on Inner Cage (inch)	Amplitude of Supports (inch)[c]	Ave. Area (sq in per ft per line)[d]
114	9½	0.69	0.41	0.28	0.41	0.041	5	2	6⅛	6.68	0.242
120	10	0.74	0.44	0.30	0.44	0.041	5	2	6½	7.16	0.242
126	10½	0.79	0.47	0.32	0.47	0.041	5	2	6⅞	7.68	0.242
132	11	0.85	0.51	0.34	0.51	0.041	5	2	7¼	8.16	0.242
144	12	0.97	0.58	0.39	0.58	0.041	5	2	8	9.16	0.242

Notes:
D-load = pound-force per linear foot per foot of diameter
D-load to produce a 0.01-inch crack: 1,350
D-lad to produce the ultimate load: 2,000
Concrete strength: 5,000 psi
Where a stirrup system is shown for a given size, it must be used with the circumferential reinforcement design selected.

(a) Two times the cross-sectional area of the wire used in the stirrup support system using 2- × 8-inch pattern for inner cage steel.

(b) Number of longitudinal lines required in the top and in the bottom portions of the pipe.

(c) Overall width of each line of stirrup support system using 2- × 8-inch pattern for inner cage steel. Use with Shearlock stirrups or S-stirrups or equal.

(d) Minimum area per support times number of supports per foot using 2- × 8-inch pattern for inner cage steel.

Table 909-3:
Additional Designs for Class IV Reinforced Concrete Pipe (AASHTO M170 Table 4 Extended)

Internal Diameter of Pipe, (in)	Minimum Wall Thickness, (in)	Reinforcement per Foot of Pipe Wall (sq in)				Stirrup Support System					
		Circular Reinforcement in Circular Pipe		Elliptical Reinforcement in Circular Pipe							
		Inner Cage	Outer Cage	Inner Circular Cage	Elliptical Cage						
		Concrete Strength, 5,500 psi				Minimum Area per Support Element (square inch)[a]	Number of Lines[b]	Long. Spacing (inch)	Circum. Spacing on Inner Cage (inch)	Amplitude of Supports (inch)[c]	Ave. Area (square inch per foot per line)[d]
78	7½	0.87	0.52	0.35	0.52						
84	8	1.00	0.60	0.40	0.64						
—	—	Concrete Strength, 5,000 psi									
78	7½	0.69	0.41	0.28	0.41	0.028	11	2	4⅛	4.67	0.167
84	8	0.74	0.44	0.30	0.44	0.028	11	2	4⅝	5.17	0.167
90	8	0.85	0.51	0.34	0.51	0.028	11	2	4⅝	5.17	0.167
96	8½	0.91	0.55	0.36	0.55	0.028	11	2	5⅛	5.67	0.167
102	8½	1.02	0.61	0.41	0.61	0.033	11	2	5⅛	5.67	0.195
108	9	1.07	0.64	0.43	0.64	0.043	11	2	5⅝	6.17	0.260
114	9½	1.02	0.61	0.41	0.61	0.047	11	2	6⅛	6.67	0.279
120	10	1.10	0.66	0.44	0.66	0.050	11	2	6½	7.17	0.298
126	10½	1.17	0.70	0.47	0.70	0.053	11	2	6⅞	7.67	0.316
132	11	1.25	0.75	0.50	0.75	0.056	11	2	7¼	8.17	0.335
144	12	1.42	0.85	0.57	0.85	0.064	11	2	8	9.17	0.381

Table 909-3 (cont.):
Additional Designs for Class IV Reinforced Concrete Pipe (AASHTO M170 Table 4 Extended)

Notes:

D-load = pound-force per linear foot per foot of diameter
D-load to produce a 0.01-inch crack: 2,000
D-load to produce the ultimate load: 3,000
Where a stirrup system is shown for a given size, it must be used with the circumferential reinforcement design selected.

(a) Two times the cross-sectional area of the wire used in the S-stirrups.

(b) Number of longitudinal lines required in the top and in the bottom portions of the pipe.

(c) Overall width of each line of stirrup support system using 2- × 8-inch in pattern for inner cage steel. Use with Shearlock stirrups or S-stirrups or equal.

(d) Minimum area per support times number of supports per foot using 2- × 8-inch pattern for inner cage steel.

Table 909-4:
Additional Designs for Class V Reinforced Concrete Pipe (AASHTO M170 Table 5 Extended)

Internal Diameter of Pipe (inch)	Wall Thickness (inch min.)	Reinforcement per Foot of Pipe Wall (sq in)				Stirrup Support System					
		Circular Reinforcement in Circular Pipe		Elliptical Reinforcement in Circular Pipe							
		Inner Cage	Outer Cage	Inner Circular Cage	Elliptical Cage	Minimum Area per Support Element (sq in)[a]	Number of Lines[b]	Long. Spacing (inch)	Circum. Spacing on Inner Cage (inch)	Amplitude of Supports (inch)[c]	Ave. Area, (square inch per foot per line)[d]
54	5½	0.64	0.38	0.26	0.38	0.028	15	2	2⅛	2.68	0.167
60	6	0.70	0.42	0.28	0.42	0.028	14	2	2⅝	3.20	0.167
66	6½	0.79	0.47	0.32	0.47	0.028	13	2	3⅛	3.68	0.167
72	7	0.87	0.52	0.35	0.52	0.028	12	2	3⅝	4.16	0.167
78	7½	0.92	0.55	0.37	0.55	0.028	11	2	4⅛	4.68	0.167
84	8	0.99	0.59	0.40	0.59	0.033	11	2	4⅝	5.16	0.195
90	8	1.13	0.68	0.45	0.68	0.040	11	2	4⅝	5.16	0.248
96	8½	1.20	0.72	0.48	0.72	0.043	11	2	5⅛	5.68	0.260
102	8½	1.34	0.80	0.54	0.80	0.051	11	2	5⅛	5.68	0.307
108	9	1.51	0.91	0.60	0.91	0.061	11	2	5⅝	6.16	0.363
114	9½	1.51	0.91	0.60	0.91	0.062	11	2	6⅛	6.68	0.372
120	10	1.62	0.97	0.65	0.97	0.067	11	2	6½	7.16	0.400

Table 909-4 (cont.):
Additional Designs for Class V Reinforced Concrete Pipe (AASHTO M170 Table 5 Extended)

Internal Diameter of Pipe (inch)	Wall Thickness (inch min.)	Reinforcement per Foot of Pipe Wall (sq in)				Stirrup Support System					
		Circular Reinforcement in Circular Pipe		Elliptical Reinforcement in Circular Pipe							
		Inner Cage	Outer Cage	Inner Circular Cage	Elliptical Cage	Minimum Area per Support Element (sq in)[a]	Number of Lines[b]	Long. Spacing (inch)	Circum. Spacing on Inner Cage (inch)	Amplitude of Supports (inch)[c]	Ave. Area, (square inch per foot per line)[d]
126	10½	1.73	1.04	0.69	1.04	0.070	11	2	6⅞	7.68	0.419
132	11	1.84	1.10	0.74	1.10	0.074	11	2	7¼	8.16	0.446
144	12	2.09	1.25	0.84	1.25	0.082	11	2	8	9.16	0.493

Notes:

D-load = pound-force per linear foot per foot of diameter
D-load to produce a 0.01-inch crack: 3,000
D-load to produce the ultimate load: 3,750
Concrete strength: 6,000 psi
Where a stirrup system is shown for a given size, it must be used with the circumferential reinforcement design selected.

(a) Two times the cross-sectional area of the wire used in the Stirrups Support System using 2 × 8-inch pattern for inner cage steel. Use with Shearlock stirrups or S-stirrups or equal.

(b) Number of longitudinal lines required in the top and in the bottom portions of the pipe.

(c) Overall width of each line of stirrups.

(d) Minimum area per support times number of supports per foot using 2 × 8-inch pattern for inner cage steel.

Table 909-5:
Additional Designs for Horizontal Elliptical Pipe

Specified Diam., Equiv. Round Size (inch)	Specified Rise by Span (inch)	Min. Wall Thick (inch)	Reinforcement (square inch per foot)													
			Class HE-A		Class HE-I		Class HE-II		Class HE-III		Class HE-IV					
			D-Loads										Stirrup Support System			
			0.01 = 600		0.01 = 800		0.01 = 1000		0.01 = 1350		0.01 = 2000		Min. Area per Support Element (square inch)	Number of Lines[a]	Long. Spacing (inch)	Circum. Spacing on Inner Cage (inch)[b]
			Ult = 900		Ult = 1200		Ult = 1500		Ult = 2000		Ult = 3000					
			In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage				
48	38 × 60	5½	—	—	—	—	—	—	—	—	0.70	0.70	0.13	15	2	3.000
54	43 × 68	6	—	—	—	—	—	—	—	—	0.82	0.82	0.15	15	2	3.375
60	48 × 76	6½	—	—	—	—	—	—	—	—	0.94	0.94	0.17	15	2	3.750
66	53 × 83	7	—	—	—	—	—	—	—	—	0.99	0.99	0.17	15	2	4.125
72	58 × 91	7½	—	—	—	—	—	—	—	—	1.11	1.11	0.19	15	2	4.500
84	63 × 98	8	—	—	—	—	—	—	—	—	1.21	1.21	0.21	15	2	4.875
78	68 × 106	8½	—	—	—	—	—	—	—	—	1.33	1.33	0.22	15	2	5.250
90	72 × 113	9	0.28	0.28	0.40	0.40	0.58	0.58	—	0.84	1.43	1.43	0.24	15	2	5.625
96	77 × 121	9½	0.30	0.30	0.45	0.45	0.65	0.65	0.92	0.92	1.56	1.56	0.26	15	2	6.000
102	82 × 128	9¾	0.33	0.33	0.52	0.52	0.73	0.73	1.03	1.03	1.72	1.72	0.28	15	2	6.188
108	87 × 136	10	0.36	0.36	0.60	0.60	0.83	0.83	1.16	1.16	1.92	1.92	0.30	15	2	6.375
114	92 × 143	10½	0.40	0.40	0.64	0.64	0.88	0.88	1.23	1.23	2.02	2.02	0.32	15	2	6.750
120	97 × 151	11	0.44	0.44	0.70	0.70	0.96	0.96	1.32	1.32	2.16	2.16	0.34	15	2	7.125

Table 909-5 (cont.):
Additional Designs for Horizontal Elliptical Pipe

Specified Diam., Equiv. Round Size (inch)	Specified Rise by Span (inch)	Min. Wall Thick (inch)	Reinforcement (square inch per foot)													
			Class HE-A		Class HE-I		Class HE-II		Class HE-III		Class HE-IV					
			D-Loads										Stirrup Support System			
			0.01 = 600		0.01 = 800		0.01 = 1000		0.01 = 1350		0.01 = 2000		Min. Area per Support Element (square inch)	Number of Lines[a]	Long. Spacing (inch)	Circum. Spacing on Inner Cage (inch)[b]
			Ult = 900		Ult = 1200		Ult = 1500		Ult = 2000		Ult = 3000					
			In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage	In Cage	Out Cage				
132	106 × 166	12	0.53	0.53	0.81	0.81	1.09	1.09	1.49	1.49	2.40	2.40	0.38	15	2	7.875
144	116 × 180	13	0.61	0.61	0.91	0.91	1.21	1.21	1.64	1.64	2.62	2.62	0.42	15	2	8.625
Concrete strength (psi)			4,000		4,000		4,000		5,000		48 inch, 54 inch, 60 inch 4,000					
											66-144 inch 5,000					

Note: Where a stirrup system is shown for a given size, it must be used with the circumferential reinforcement design selected.

(a) Number of longitudinal lines required in the top and in the bottom portions of the pipe.

(b) Overall width of each line of stirrups.

Table 909-6:
References for Spiral Ribbed and Corrugated Metal Pipes

	Driveway Culverts and Downspouts	Culverts	Sewers
	Minimum Design Life		
Pipe Material Type	**25 years**	**50 years**	**70 years**
Galvanized spiral ribbed metal pipe	Table 909-8	0.109[(a)]	0.168[(a)]
Aluminized Type 2 spiral ribbed metal pipe	Table 909-8	Table 909-11	0.138[(a)]
Polymer-precoated spiral ribbed metal pipe	Table 909-8	Table 909-8	Table 909-8
Galvanized corrugated metal pipe	Table 909-7	Table 909-9	0.168[(a),(b)]
Aluminized Type 2 corrugated metal pipe	Table 909-7	Table 909-10	0.138[(a),(b)]
Polymer-precoated corrugated galvanized pipe	Table 909-7	Table 909-7	Table 909-7[(b)]
Aluminum pipe	Table 909-12	Table 909-13	Table 909-14
Aluminum spiral ribbed pipe	Table 909-15	Table 909-16	Table 909-17
Dual-wall polymer-precoated galvanized corrugated steel pipe	Table 909-20	Table 909-20	Table 909-20

Notes:

Minimum wall thickness in inches to meet structural and durability requirements for various metal pipes to meet the design life.
Numbers represent the minimum durability gage requirements for the specific pipe material.
Table 909-7 represents the minimum structural gauge thickness requirements for corrugated steel pipe.
Table 909-8 represents the minimum structural gauge thickness requirements for spiral ribbed steel pipe.

(a) Required wall thickness (inch).

(b) Permitted for 12- to 18-inch-diameter 2⅔- × ½-inch helically corrugated pipe only.

Table 909-7:
Wall Thickness Requirements in Inches, Based on Diameter Class of Pipe and Size of Corrugation

Pipe Diameter (inch)	Depth of Cover							
	0–16 feet		>16–24 feet			>24–32 feet		
	Corrugation Size (inch)							
	2⅔ × ½	3 × 1, 5 × 1	2⅔ × ½	3 × 1	5 × 1	2⅔ × ½	3 × 1	5 × 1
	Required Wall Thickness (inch)							
12–30	0.064	—	0.064	—	—	0.064	—	—
36–48	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
54	0.079	0.064	0.079	0.064	0.064	0.079	0.064	0.064
60	0.109	0.064	0.109	0.064	0.064	0.109	0.064	0.064
66	0.138	0.064	0.138	0.064	0.064	0.138	0.064	0.064
72	0.138	0.064	0.138	0.064	0.064	0.138	0.064	0.064
78	0.168	0.064	0.168	0.064	0.064	0.168	0.064	0.064
84	0.168	0.064	0.168	0.064	0.064	0.168	0.064	0.079
90	—	0.064	—	0.064	0.064	—	0.079	0.079
96	—	0.079	—	0.079	0.079	—	0.079	0.079
102	—	0.079	—	0.079	0.079	—	0.079	0.109
108–120	—	0.109	—	0.109	0.109	—	0.109	0.109
126	—	0.138	—	0.138	0.138	—	0.138	0.138
130–136	—	0.138	—	0.138	0.138	—	0.138	0.138
144	—	0.168	—	0.168	0.168	—	0.168	0.168

Table 909-8:
Wall Thickness Requirements in Inches Based on Diameter, Class of Pipe, and Size of Ribs

Pipe Diameter (inch)	Depth of Cover					
	0–16 feet		>16–24 feet		>24–32 feet	
	Corrugation Size (inch)					
	¾ × ¾ × 7½	¾ × 1 × 11½	¾ × ¾ × 7½	¾ × 1 × 11½	¾ × ¾ × 7½	¾ × 1 × 11½
	Required Wall Thickness (inch)					
18–36	0.064	0.064	0.064	0.064	0.064	0.064
42	0.064	0.064	0.064	0.064	0.064	0.079
48	0.064	0.064	0.064	0.079	0.064	0.079
54	0.079	0.064	0.079	0.079	0.079	0.109
60	0.079	0.079	0.079	0.079	0.079	0.109
66	0.109	0.079	0.109	0.109	0.109	0.109
72–78	0.109	0.109	0.109	0.109	0.109	0.109
84	—	0.109	—	0.109	—	0.109

Table 909-9:
Wall Thickness Requirements in Inches Based on Class of Pipe and Size of Corrugation

Pipe Diameter (inch)	Class A and Class B		Class C		Class D		
	Corrugation Size (inch)						
	2⅔ × ½	3 × 1, 5 × 1	2⅔ × ½	3 × 1, 5 × 1	2⅔ × ½	3 × 1	5 × 1
	Required Wall Thickness (inch)						
12–30	0.109	—	0.109	—	0.109	—	—
36–60	0.109	0.109	0.109	0.109	0.107	0.109	0.109
66–72	0.138	0.109	0.138	0.109	0.138	0.109	0.109
78–84	0.168	0.109	0.168	0.109	0.168	0.109	0.109
90–102	—	0.109	—	0.109	—	0.109	0.109
108–120	—	0.109	—	0.109	—	0.109	0.109
126	—	0.138	—	0.138	—	0.138	0.138
130–136	—	0.138	—	0.138	—	0.138	0.138
144	—	0.168	—	0.168	—	0.168	0.168

Table 909-10:
Wall Thickness Requirements in Inches Based on Diameter, Class of Pipe and Size of Corrugation

Pipe Diameter (inch)	Class A and B		Class C			Class D		
	Corrugation Size (inch)							
	2⅔ × ½	3 × 1, 5 × 1	2⅔ × ½	3 × 1	5 x 1	2⅔ × ½	3 × 1	5 x 1
	Required Wall Thickness (inch)							
12–30	0.079	—	0.079	—	—	0.079	—	—
36–54	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
60	0.109	0.079	0.109	0.079	0.079	0.109	0.079	0.079
66–72	0.138	0.079	0.138	0.079	0.079	0.138	0.079	0.079
78–84	0.168	0.079	0.168	0.079	0.079	0.168	0.079	0.079
90–96	—	0.079	—	0.079	0.079	—	0.079	0.079
102	—	0.079	—	0.079	0.079	—	0.079	0.109
108–120	—	0.109	—	0.109	0.109	—	0.109	0.109
126	—	0.138	—	0.138	0.138	—	0.138	0.138
130–136	—	0.138	—	0.138	0.138	—	0.138	0.138
144	—	0.168	—	0.168	0.168	—	0.168	0.168

Table 909-11:
Wall Thickness Requirements in Inches Based on Diameter, Class of Pipe, and Size of Ribs

Pipe Diameter (inch)	Class A and B		Class C		Class D	
	Corrugation Size (inch)					
	¾ × ¾ × 7½	¾ × 1 × 11½	¾ × ¾ × 7½	¾ × 1 × 11½	¾ × ¾ × 7½	¾ × 1 × 11½
	Required Wall Thickness (inch)					
18–48	0.079	0.079	0.079	0.079	0.079	0.079
54–60	0.079	0.079	0.079	0.079	0.079	0.109
66–78	0.109	0.109	0.109	0.109	0.109	0.109
84	—	0.109	—	0.109	—	0.109

Table 909-12:
Wall Thickness Requirements in Inches, Based on Class of Pipe and Size of Corrugation, Lock Seam Pipe Only

Pipe Diameter (inch)	Depth of Cover					
	0–16 feet		>16–24 feet		>24–32 feet	
	Corrugation Size (inch)					
	2⅔ × ½	3 × 1	2⅔ × ½	3 × 1	2⅔ × ½	3 × 1
	Required Wall Thickness (inch)					
12–27	0.060	0.060	0.060	0.060	0.060	0.060
30–36	0.075	0.060	0.075	0.060	0.075	0.060
42–54	0.105	0.060	0.105	0.060	0.105	0.060
60	0.135	0.075	0.135	0.075	0.135	0.075
66–72	0.164	0.075	0.164	0.075	0.164	0.075
78	—	0.075	—	0.075	—	0.075
84–96	—	0.105	—	0.105	—	0.105
102–108	—	0.135	—	0.135	—	0.135
112–120	—	0.164	—	0.164	—	0.164

Table 909-13:
Wall Thickness Requirements in Inches, Based on Class of Pipe and Size of Corrugation, Lock Seam Pipe Only

Pipe Diameter (inch)	Class A, B, C, D Corrugation Size (inch)	
	2⅔ × ½	3 × 1
	Required Wall Thickness (inch)	
12–36	0.075	0.075
42–54	0.105	0.075
60	0.135	0.075
66–72	0.164	0.075
78	—	0.075
84–96	—	0.105
102–108	—	0.135
112–120	—	0.164

Table 909-14:
Wall Thickness Requirements in Inches, Based on Class of Pipe and Size of Corrugation, Lock Seam Pipe Only

Pipe Diameter (inch)	Class A, B, C, D Corrugation Size (inch)	
	2⅔ × ½	3 × 1
	Required Wall Thickness (inch)	
12–54	0.105	0.105
60	0.135	0.105
66–72	0.164	0.105
78–96	—	0.105
102–108	—	0.135
112–120	—	0.164

Table 909-15:
Wall Thickness Requirements in Inches, Based on Diameter, Class of Pipe, and Size of Rib, Lock Seam Pipe Only

Pipe Diameter (inch)	Class F, ¾ × ¾ × 7½
	Required Wall Thickness (inch)
18–24	0.060
30–36	0.075
42–54	0.105
60–66	0.135

Table 909-16:
Wall Thickness Requirements in inches, Based on Diameter, Class of Pipe, and Size of Rib, Lock Seam Pipe Only

	Class A, B, C, D ¾ × ¾ × 7½
Pipe Diameter (inch)	Required Wall Thickness (inch)
18–36	0.075
42–54	0.105
60–66	0.135

Table 909-17:
Wall Thickness Requirements in Inches, Based on Diameter, Class of Pipe, and Size of Rib, Lock Seam Pipe Only

	Class A, B, C, D ¾ × ¾ × 7½
Pipe Diameter (inch)	Required Wall Thickness (inch)
18–54	0.105
60–66	0.135

Table 909-18:
Jacked-in-Place Steel Pipe Nominal OD and Wall Thickness

Nominal Size (inch)	Nominal Outside Diameter (inch)	Wall Thickness (inch)
2	2.375	0.154
4	4.500	0.188
6	6.625	0.188
8	8.625	0.188
10	10.750	0.188
12	12.750	0.188
14	14.000	0.250
16	16.000	0.250
18	18.000	0.250
20	20.000	0.250
24	24.000	0.250
30	30.000	0.312
36	36.000	0.312
42	42.000	0.438
48	48.000	0.500
54	54.000	0.563

Table 909-19:
Gage Equivalents to Nominal Thickness

Sheet Gauge Number	Nominal Thickness	
	Galvanized	Aluminum Alloy
18	0.052	0.048
16	0.064	0.060
14	0.079	0.075
12	0.109	0.105
10	0.138	0.135
8	0.168	0.164
7	0.188	—
5	0.218	—
3	0.249	—
1	0.280	—

Table 909-20:
Dual Wall Polymer-Precoated Galvanized Corrugated Steel Pipe Wall Thickness Requirements in inches Based on Diameter and Size of Corrugation

Diameter of Pipe (inch)	Corrugation Size (inch)			
	2⅔ × ½		3 × 1	
	Shell	Liner	Shell	Liner
	Required Wall Thickness (inch)			
36–48	0.064	0.052	0.064	0.052
54	0.079	0.052	0.064	0.052
60	0.109	0.052	0.064	0.052
66–72	0.138	0.052	0.064	0.052
78–84	0.168	0.052	0.064	0.052
90–102	—	—	0.079	0.052
108–120	—	—	0.109	0.052
126–136	—	—	0.138	0.052
144	—	—	0.168	0.052

Table 909-21:
Corrugated Steel Pipe (CSP) AASHTO LRFD Cover Heights for CSP Pipe-Arch 3 x 1 inch

Span x Rise (inch)	Equiv Diam. (inch)	Min. Nominal Thickness (inch)[(a)]	Min. Cover (feet)	Max. Cover (feet)
53 x 41	48	0.079	2.0	11
60 x 46	54	0.079	2.0	20
66 x 51	60	0.079	1.2	20
73 x 55	66	0.079	1.2	20
81 x 59	72	0.079	1.5	16
87 x 63	78	0.079	1.5	16
95 x 67	84	0.079	1.5	16
103 x 71	90	0.079	1.5	16
112 x 75	96	0.109	1.5	16
117 x 79	102	0.109	1.5	16
128 x 83	108	0.138	1.5	16
137 x 87	114	0.138	1.6	16
142 x 91	120	0.138	1.6	16

(a) Manufacturing limitations include a 0.079-inch minimum nominal thickness for 3- x 1-inch pipe-arch.

Table 909-22:
Corrugated Steel Pipe (CSP) AASHTO LRFD Cover Heights for CSP Pipe-Arch, 5 x 1 inch

Span x Rise (inch)	Equiv Diam. (inch)	Min. Nominal Thickness (inch)[(a)]	Min. Cover (feet)	Max. Cover (feet)
53 x 41	48	0.109	2.0	11
60 x 46	54	0.109	1.2	20
66 x 51	60	0.109	1.2	20
73 x 55	66	0.109	1.2	20
81 x 59	72	0.109	1.5	16
87 x 63	78	0.109	1.5	16
95 x 67	84	0.109	1.5	16
103 x 71	90	0.109	1.5	16
112 x 75	96	0.109	1.5	16
117 x 79	102	0.109	1.5	16
128 x 83	108	0.138	1.5	16
137 x 87	114	0.138	1.6	16
142 x 91	120	0.138	1.6	16

(a) Manufacturing limitations include a 0.109-inch minimum nominal thickness for 5- x 1-inch pipe-arch.

Table 909-23:
Corrugated Steel Pipe (CSP) AASHTO LRFD Cover Heights for CSP Pipe-Arch 2⅔ inch x ½ inch

Span x Rise (inch)	Equiv Diam. (inch)	Min. Nominal Thickness (inch)	Min. Cover (feet)	Max. Cover (feet)
17 x 13	15	0.064	1.9	12
21 x 15	18	0.064	2.0	12
24 x 18	21	0.064	1.9	12
28 x 20	24	0.064	2.0	12
35 x 24	30	0.064	2.0	12
42 x 29	36	0.064	2.0	12
49 x 33	42	0.079	2.0	12
57 x 38	48	0.109	2.0	11
64 x 43	54	0.109	2.0	11
71 x 47	60	0.138	2.0	11
77 x 52	66	0.168	2.0	12
83 x 57	72	0.168	2.0	12

Table 909-24:
Corrugated Steel Pipe (CSP) AASHTO LRFD Cover Heights for CSP Pipe-Arch ¾ inch x ¾ inch x 7½ inch Spiral Rib Pipe

Span x Rise (inch)[a]	Equiv Diam. (inch)	Min. Nominal Thickness (inch)	Min. Cover (feet)	Max. Cover (feet)
20 x 16	18	0.064	1.6	15
23 x 19	21	0.064	1.7	14
27 x 21	24	0.064	1.8	13
33 x 26	30	0.064	1.8	13
40 x 31	36	0.064	1.9	13
46 x 36	42	0.064	1.8	13
53 x 41	48	0.064[b]	1.9	13
60 x 46	54	0.079	1.3	20
66 x 51	60	0.079[b]	1.3	20
73 x 55	66	0.109	1.3	20
81 x 59	72	0.109[b]	1.5	16
87 x 63	78	0.138	1.5	16
95 x 67	84	0.138	1.5	16
103 x 71	90	0.138[b]	1.5	16

(a) ASTM A760 makes provisions for two additional sizes: 112 x 75 inch and 117 x 79 inch.

(b) Trench installation only. Embankment installations may be used for the heavier gauges.

Section 910. Geosynthetics

910.01. General Requirements

Geosynthetics must be composed of long chain synthetic fiber of at least 85% (by weight) polyolefins or polyesters. Geosynthetics must be capable of resisting degradation from chemicals, mildew, rot, and ultraviolet (UV) light.

Deliver and store geosynthetics in packaging capable of resisting UV radiation, contaminants, and moisture. Label each unit of material with product information including supplier and lot identification. Do not expose geosynthetics to direct sunlight for prolonged periods. Repair or replace damaged geosynthetics at no additional cost to the Department.

910.02. Testing

Geosynthetic testing will be in accordance with the specified ASTM or Department methods, as modified by this section.

Geosynthetics must meet the physical property requirements shown in Tables 910-1 and 910-2. The directional property values listed in Table 910-1 specify values for the weaker principal direction.

910.03. Geotextiles

Geotextiles are flexible, permeable fabrics, consisting of synthetic fibers or yarns oriented into a dimensionally stable network. Woven geotextiles must have sealed or selvaged edges to prevent raveling.

A. **Geotextile Blanket.** Geotextile for filtration applications, including trench lining, ditch lining, streambed protection, pipe wrap, joint wrap, drainhole and weephole filter, granular blanket separation, and filter bags must be non-woven and meet the requirements shown in Table 910-1 for geotextile blanket.

B. **Geotextile Liner.** Geotextile for erosion control in riprap and similar applications must be non-woven and meet the requirements shown in Table 910-1 for geotextile liner. Geotextile for use with heavy riprap must be non-woven and meet the requirements shown in Table 910-1 for heavy geotextile liner.

C. **Geotextile Separator.** Geotextile used to prevent intermixing of dissimilar aggregate or soil layers must meet the requirements shown in Table 910-1 for geotextile separator. Geotextiles separators with grab tensile elongation-at-break less than 50% must meet the requirements shown in Table 910-1 for woven geotextile separator. Geotextiles with grab tensile elongation-at-break equal to or greater than 50% must meet the strength requirements shown in Table 910-1 for non-woven geotextile separator.

D. **Stabilization Geotextile.** Geotextile used to prevent intermixing of soft subgrade and subbase materials must meet the requirements shown in Table 910-1 for stabilization geotextile.

Stabilization geotextile with grab tensile elongation-at-break less than 50% must meet the requirements shown in Table 910-1 for woven stabilization geotextile. Geotextiles with grab tensile elongation-at-break equal to or greater than 50% must meet the strength requirements shown in Table 910-1 for non-woven stabilization geotextile.

910.04. Silt Fence Geotextile

Select geotextile for fabricating silt fence from the Qualified Products List. Geotextile for silt fence must have a nominal height of 3 feet and must meet the requirements shown in Table 910-1 for silt fence. Geotextile for silt fence must have a retained strength of at least 70% after 500 hours of UV exposure when tested in accordance with ASTM D4355/D4355M. Fabricate silt fence according to subsection 916.02.

910.05. Drainage Geocomposites

Drainage geocomposites must meet the requirements shown in Table 910-1 and this subsection.

Prefabricated geocomposites for drainage applications must consist of a geotextile bonded to or wrapped around a polymer core having corrugated, dimpled, tubular, or net (mesh) configurations. Geocomposites must have sufficient flexibility and durability to withstand installation, handling, and permanent loading stresses.

Fittings for geocomposite installations must be manufactured by the geocomposite manufacturer or meet the published specifications of the geocomposite manufacturer. Provide tape used to seal connections with adhesive resistant to moisture and organic growth and recommended by the manufacturer for underground service conditions.

Obtain the Engineer’s approval for all components of the geocomposite system before installation.

A. **Wall Drain.** Wall drains for single-direction cross-planar flow must consist of an impermeable polymer core with geotextile bonded to one side. The geocomposite must have a minimum crush strength of 4,000 pounds per square foot at no more than 18% deformation when tested according to MTM 411.

B. **Geocomposite Net.** The Engineer may allow geocomposite net consisting of geotextile blanket bonded to both sides of a mesh core as an alternative to open-graded aggregate drainage layers.

The Engineer will approve the geocomposite net based on durability, drainage capacity, crush resistance, tensile strength, and thickness.

910.06. Road Grade Biaxial Geogrid

The geogrid must be a regular grid structure and must have aperture geometry and rib and junction cross-section sufficient to permit significant mechanical interlock with the material being reinforced. The geogrid must have significant dimensional stability through all ribs and junctions of the grid structure. The geogrid must maintain its reinforcement and interlock capabilities under repeated dynamic loads while in service. The geogrid must also be resistant to UV degradation, to damage under normal construction practices, and to all forms of biological or chemical degradation normally encountered in highway construction.

The geogrid must be composed of polypropylene, HDPE, or polyester virgin resins. The protective coatings of polyester geogrids must contain less than 5% filler content. Repair damaged coating prior to backfilling. The geogrid must meet the physical property requirements of Table 910-2.

Table 910-1:
Physical Requirements for Geotextiles

	Property				
	Grab Tensile Strength (min.) (lb)	Trapezoid Tear Strength (min.) (lb)	Puncture Strength (min.) (lb)	Permittivity (min.) (per second)	Apparent Opening Size (max.) (mm)
	Test Method				
Geotextile Category	ASTM D4632/ D4632M	ASTM D4533/ D4533M	ASTM D6241	ASTM D4491/ D4491M	ASTM D4751
Geotextile blanket[(a)]	120	45	230	0.5	0.21
Geotextile liner	200	75	440	0.5	0.21
Heavy geotextile liner	270	100	620	0.5	0.21
Woven geotextile separator	270	100	620	0.05	0.425
Non-woven geotextile separator	200	75	440	0.5	0.425
Woven stabilization geotextile	270	100	620	0.05	0.50
Non-woven stabilization geotextile	270	100	620	0.5	0.50
Silt fence	100[(b)]	45	—	0.1	0.60
Drainage geocomposites	200	75	440	0.5	0.21

(a) For pipe wrap where backfill around the pipe meets granular material Class IIAA requirements; geotextiles, including knitted polyester sock, which meet the following minimum requirements in the applied condition, are permitted: mass/unit area: 3.0 oz/yd²; Mullen burst strength: 100 psi; maximum apparent opening size must be 0.30 mm for pavement and foundation underdrains and 0.60 mm in other areas. The fluid displacement rate for the Mullen burst test equipment must be 170 mL/min ± 5 mL/min. Subtract tare strength from the ultimate burst strength as specified in ASTM D3786/D3786M.

(b) Elongation at the specified grab tensile strength no greater than 40% for silt fence.

Table 910-2:
Physical Requirements for Road Grade Biaxial Geogrid

Property	Minimum Value (except where noted below)	Test Method
Interlock open area	60%	U.S. Army Corps of Engineers[a]
Ultimate strength		ASTM D6637/D6637M[b]
MD[c]	1200 lb/ft	
MD[c]	1950 lb/ft	
Individual junction strength		ASTM D7737/D7737M
MD[c]	130 lb	
CMD[c]	170 lb	
Tensile modulus (2%)		ASTM D6637/D6637M[b]
MD[c]	18,000 lb/ft	
CMD[c]	30,000 lb/ft	
Aperture size		Measured
MD[c]	1.0 inch (nominal value)	
CMD[c]	1.3 inch (nominal value)	

(a) Percent open area measured without magnification by means of U.S. Army Corps of Engineers method as specified in CW 02215, Civil Works Construction Guide Specification for Plastic Filter Fabric (1977).

(b) Ultimate strength and tensile modulus at 2% elongation measured by means of ASTM D6637/D6637M. No offset allowances or specimen pretensioning are made in calculating tensile modulus.

(c) MD (machine direction) and CMD (cross-machine direction) refer to the principal directions of the manufacturing process.

Section 911. Water

911.01. General Requirements

Water must be clean, clear, and free of oil, salt, acid, alkali, organic matter, chlorides, or other deleterious material.

911.02. Turf, Turf Establishment, and Landscape Plants

Provide water from a potable or non-potable water source approved by the Engineer. Use irrigation-quality water that is free of elements harmful to plant growth.

911.03. Mixing or Curing Concrete, Mortar, Grout, and Other Cementitious Products

Potable water from sources approved by the Michigan Department of Public Health or equivalent approved by the Engineer is acceptable without testing.

Surface water from sources including, but not limited to, ditches, lakes, ponds, quarries, rivers, streams, wetlands, and other similar untreated sources is prohibited for mixing or curing concrete, mortar, grout, and other cementitious products. Stationary concrete batch plants may use surface water if the facility has established at least a 5-year history of producing consistent concrete products meeting the required specifications. Stationary concrete batch plants using surface water are required to meet the non-potable water sampling and testing requirements.

Non-potable must meet the requirements of Table 911-1. Do not use non-potable water unless approved by the Engineer.

Test non-potable water prior to use, once per month (once per 6 months for stationary concrete batch plants) thereafter, and at any time the water source may be deemed out of compliance due to changing site conditions as determined by the Engineer. Water must be sampled and tested by a qualified independent testing laboratory having no association with the supply or production of materials produced by that concrete facility at the expense of the Contractor. Submit test results to the Engineer for approval prior to use and within 3 days of completion of testing. If water fails to meet the requirements of this specification, immediately suspend use of water source, bring water into compliance, and retest. Do not resume use of the water source until approved by the Engineer.

Table 911-1:
Non-Potable Water Requirements

Property	Test Method	Specification
Total solids	ASTM C1602	≤0.30%
Total organic content / carbon	SM 2540 E	≤0.05%
Alkalinity-acidity (pH)	ASTM D1067	5.5–8.5
Chloride (Cl-)	ASTM D512	≤0.05%
Time of setting	ASTM C1602	–1:00 hour to +1:30 hours of control
7-day compressive strength	ASTM C1602	≥90% of control

Section 912. Timber and Lumber

912.01. General Requirements

Timber and lumber, timber piles, posts and blocks for guardrails, sign posts, mailbox posts, guard posts, guide posts, fence posts, and timber for rustic construction must meet the requirements of this section.

In case of a conflict between the American Wood Protection Association (AWPA) and ASTM International (ASTM) standards, the AWPA standards take precedence.

Machine or manufacture material, including bored holes, saw cuts, routs, and kerfs, to the required shape before applying preservative treatment.

The commercial and common names for domestic hardwood and softwood timber and lumber are as specified in ASTM D1165.

912.02. Quality Control

A. **General.** The supplier is responsible for QC and inspection of material. Material must be graded before shipment in accordance with the grading rules of ASTM D245 and marked with the approved grading agency stamp showing the mill origin, species, and grade. The required grading agency stamp or marking must be legible on a wide face at the trimmed end before and after treating.

B. **Inspection Prior to Preservative Treatment.** Before treating timber and lumber, inspect material for quality, size, and straightness. This inspection does not waive the Department's right to inspect and reject material in accordance with subsection 105.05.

C. **Inspection of Preservative Treatment.** Inspect chemical preservatives, treatment processes, and treated material in accordance with AWPA M2, "Standard for Inspection of Wood Products Treated with Preservatives," and AWPA M3, "Standard Quality Control Procedures for Wood Preserving Plants," and other relevant AWPA standards. The treater must determine whether the preservatives that are used conform to the requirements.

   For single treatment charges, analyze the preservative at least once per charge. For consecutive treatments from the same working tank, analyze the first charge and at least one of every five additional charges, selected at random.

   Collect preservative samples that are representative of the solution used in the actual treatment process.

D. **Results of Treatment.** Ensure that the treatment results, including preservative analysis and penetration and retention determinations, meet AWPA standards.

E. **Inspection Records.** Provide a signed inspection certificate for each material shipment. Provide copies of treatment records, analysis records, and other records ensuring that the treatment conforms to specification requirements to the Engineer upon request. Retain the records at the treatment plant for at least 5 years from the date the material is shipped to the project. Refer to AWPA M2 for required information.

F. **Painting Treated Wood.** Air season wood for at least 30 days and remove preservative dust from the wood before painting.

912.03. Field Treatment of Preservative Treated Material

A. **General.** Field treat saw cuts, routs, kerfs, holes, and other injuries to preservative-treated material occurring after pressure treatment by brushing, dipping, soaking, or coating. Do not spray. Saturate injuries with the field-treating solution. Fill bored holes with preservative.

The Contractor may fill horizontal holes by temporarily plugging one end of a hole and using a bent funnel to pour preservative into the other end of the hole.

B. **Preservative.** Use a 2.0% solution of copper naphthenate, based on copper as metal, meeting the requirements for AWPA M4 for field treatment. Ensure that a State of Michigan Certified Commercial Pesticide Applicator applies the copper naphthenate.

912.04. Terminology Used in Timber and Lumber Specifications

Refer to ASTM D9 and AWPA M5, “Glossary of Terms Used in Wood Preservation,” for additional wood and wood preservation terms.

Annual Ring. Growth layer produced by the tree in a single growth year, including earlywood and latewood.

Bark. Layer of a tree, outside the cambian, comprising the inner bark or thin, inner living part (phloem) and the outer bark or corky layer composed of dry, dead tissue.

Bird Peck. Small hole or patch of distorted grain resulting from birds pecking through the growing cells in the tree. Bird peck usually resembles a carpet tack with the point toward the bark, and it is usually accompanied by discoloration extending for a considerable distance along the grain and to a much lesser extent across the grain. The discoloration produced by bird peck causes what is commonly known as mineral streak.

Boxed Heart. Term used when the pith falls entirely within the four faces of a piece of wood anywhere in its length. Also called boxed pith.

Check. Lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses set up in wood during seasoning. Checks are measured as an average of the penetration perpendicular to the wide face. Where two or more checks appear on the same face, only the deepest one is measured. Where two checks are directly opposite each other, the sum of their depths is used.

Contiguous Checks. Individual checks that are adjoining though not in contact with adjacent checks.

Crook or Sweep. Distortion of a piece of lumber or post in which there is a deviation in a direction perpendicular to the edge from a straight line from end to end of the piece.

Decay. Decomposition of wood substance caused by action of wood destroying fungi, resulting in softening, loss of strength and weight, and often in change of texture and color.

Advanced (or typical) Decay. Older stage of decay in which the destruction is readily recognized because the wood has become punky, soft and spongy, stringy, ring-shaked, pitted, or crumbly. Decided discoloration or bleaching of the rotted wood is often apparent.

Incipient Decay. Early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood. It is usually accompanied by a slight discoloration or bleaching of the wood.

Defect. Any irregularity or imperfection occurring in or on the wood that may lower its durability or strength.

Grain. Direction, size, arrangement, appearance, or quality of the fibers in wood or lumber.

Heartwood. Wood extending from the pith to the sapwood, the cells of which no longer participate in the life processes of the tree. Heartwood may be infiltrated with gums, resins, and other materials that usually make it darker and more decay resistant than sapwood.

Knot. Portion of a branch or limb that has been surrounded by subsequent growth of the wood of the trunk or other portion of the tree. As a knot appears on the sawed surface, it is merely a section of the entire knot, its shape depending on the direction of the cut. Knot diameter is measured as shown in Figure 912-1. The smallest dimension is used to determine size of the knot.

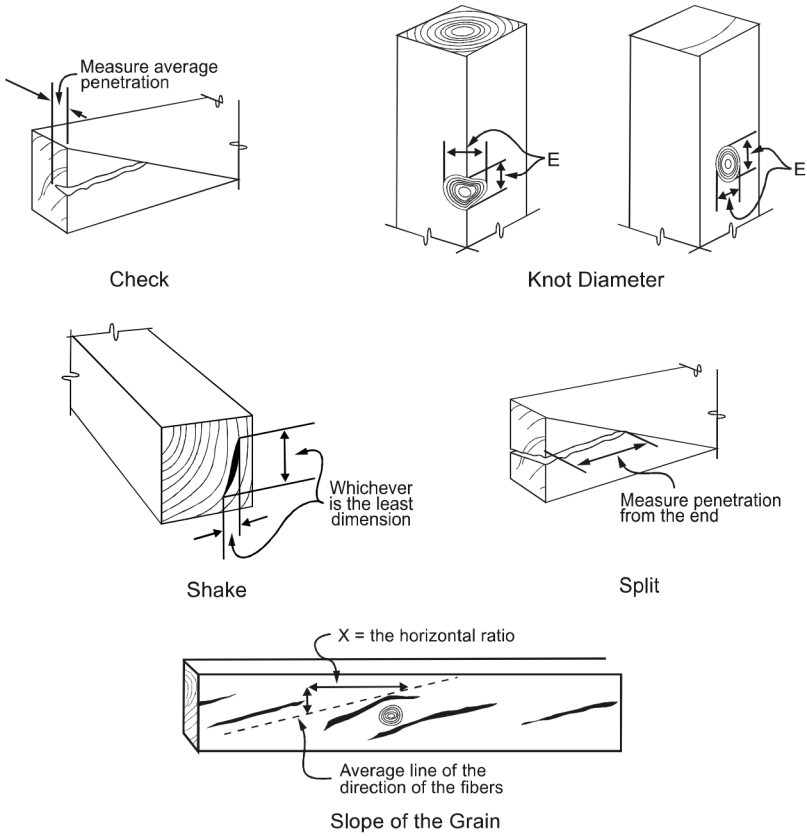

Figure 912-1: Measurement of Timber / Lumber Defects

Knot Cluster. Three or more knots in a compact, roughly circular group, with the grain between them highly contorted. Two or more knots arranged laterally and without contortion of the fibers between them do not constitute a knot cluster.

Loose Knot. Knot that is not held firmly in place by growth or position and that cannot be relied upon to remain in place.

Sound Knot. Knot that is solid across its face, at least as hard as the surrounding wood, and shows no indication of decay.

Unsound Knot. Knot that, due to decay, is softer than the surrounding wood.

Mineral Streak. Olive to greenish-black or brown discoloration of undetermined cause in hardwoods, particularly hard maples; commonly associated with bird pecks and other injuries; occurs in streaks usually containing accumulations of mineral matter.

Peeling (clean). Removal of all outer bark and at least 80% of the inner bark distributed over the surface of the post, pile, or block.

Pith. Small, soft core in the structural center of a tree trunk, branch, twig, or log.

Plugged Hole. Any opening, or defect, that has been filled or repaired through the use of wooden plugs, plastic wood, or other methods. Holes resulting from the taking of test cores by an increment borer to check penetration or retention of preservative and filled with tight-fitting pressure treated plugs are not considered plugged holes for rejection purposes.

Sapwood. Living wood of pale color near the outside of the log. Under most conditions, sapwood is more susceptible to decay than heartwood.

Shake. Separation along the grain, the greater part of which occurs between the rings of annual growth. Shakes are measured at the ends of pieces between lines parallel with the two faces that give the smallest dimension.

Slope of Grain. Deviation of the wood fiber from a line parallel to the edges of a piece. The deviation is expressed as a ratio, such as a slope of grain of one in eight. Generally, slope of grain is measured over sufficient length and area to be representative of the general slope of the fibers, disregarding local variations.

Split. Lengthwise separation of the wood extending through the piece from one surface to an opposite or to an adjoining surface due to the tearing apart of wood cells. Splits are measured as the penetration of a split from the end of the piece and parallel to edges of the piece.

Twist. Distortion caused by the turning or winding of the edges of a board so the four corners of any face are no longer in the same plane.

Unsightly Gaps. The term as used in these specifications is interpreted as being any gap or opening that is more than ⅜ inch at its maximum width and more than 12 inches long.

Wane. Bark or lack of wood from any cause on edge or corner of piece.

912.05. Structural Timber and Lumber

A. **Grade.** Provide structural timber and lumber of the grade required as determined by the grading and dressing requirements of ASTM D245.

B. **Species.** Use species included in AWPA U1, table in Section 5, “Species Names and Listings in U1 – Use Category System: User Specification for Treated Wood Products.”

C. **Preservative Treatment.** Condition and treat structural timber and lumber in accordance with AWPA U1, Commodity Specification A. Refer to Use Category 4A (UC4A) for above-ground requirements and Use Category 4C (UC4C) for ground-contact requirements.

D. **Preservatives.** Provide preservatives meeting the requirements of AWPA U1, Section 4, “Standardized Preservatives (Informative)” and the relevant P Standards.

912.06. Timber Piles

A. **Physical Characteristics and Species.** Provide timber piles of southern pine, red pine, jack pine, ponderosa pine, Douglas-fir, western larch, lodgepole pine, or red oak. Before applying preservative treatment, ensure that timber piles meet the requirements of ASTM D25 except as modified by this subsection.

B. **Dimensions.** Ensure that the pile circumference measured under the bark meets the requirements of Table 912-1, except that 10% of the piles in a shipment lot may have circumferences 2 inches less than the minimum values. Ensure that piles do not exceed the 1:2 maximum to minimum diameter ratio measured at the butt of the pile.

Table 912-1:
Circumferences and Diameters of Timber Piles

Timber Pile	Length (feet)	3 feet from Butt				At Tip	
		Minimum		Maximum		Minimum	
		Circum. (inch)	Diameter (inch)	Circum. (inch)	Diameter (inch)	Circum. (inch)	Diameter (inch)
Douglas-fir, larch, pine, or tamarack	<40	38	12	63	20	25	8
	40–50	38	12	63	20	22	7
	≥50–70	41	13	63	20	22	7
	≥70–90	41	13	63	20	19	6
	>90	Dimensions must be as specified in the proposal or on the plans.					
Oak or cypress	<30	38	12	57	18	25	8
	30–40	41	13	63	20	22	7
	>40	41	13	63	20	19	6

C. **Sapwood.** Provide piles with a sapwood thickness of at least 1 inch at the butt end.

D. **Straightness.** Use straight piles as determined by drawing a line from the center of the butt to the center of the tip and ensuring the line lies within the pile body. Use only piles with a uniform taper from butt to top and without short crooks.

E. **Knots.** Provide piles free of unsound and loose knots. Piles may contain sound knots no greater than 4 inches in diameter or one-third of the shortest pile dimension at the knot location, except for piles used as structural members in exposed work. Ensure that piles used as structural members in exposed work do not contain sound knots with diameters greater than one-fourth of the shortest pile dimension at the knot location.

F. **Checks.** Do not use piles with checks wider than ¼ inch or deeper than 2 inches.

G. **Peeling (Shaving).** Piles must meet the requirements for clean-peeled posts as specified by subsection 912.07.I.

H. **Preservative Treatment.** Perform preservative treatment of timber piling in accordance with the AWPA Use Category UC4C for foundation, land, and fresh water exposure. Submit certification from the treatment plant stating type, pressure process used, net amount of preservative retained and compliance with relevant standards to the Engineer. Preservative penetration and retention must meet the requirements of AWPA U1 Table 3.0, Use Category 4 (UC4C).

I. **Preservatives.** Provide preservatives for treatment meeting the requirements of AWPA U1, Section 4, “Standardized Preservatives (Informative)” and the applicable P Standards.

912.07. Timber Posts

A. **General.** Use posts cut from live timber without bird pecks or insect holes. Saw post ends square.

B. **Species and Grades.** Provide fence posts, guide posts, guard posts, and mailbox posts manufactured from the species specified in Table 912-2.

Table 912-2:
Species and Grading Requirements for Posts

Species	Round Posts Grade	Grading Rules Agency
Hardwoods	ASTM D245	MDOT
Red oak (northern red, black, pin laurel, cherry-bark, scarlet, water, willow oaks)[(a)]		
Hard maple (black and sugar), red maple		
White ash		
White-heartwood beech		
Yellow birch		
Softwoods		
Northern white cedar, red pine, eastern white pine (northern white pine)	No. 1 or better	NHPMA
Douglas-fir	No. 2 or better	WCLIB, WWPA
Southern pine species	No. 2 or better	SPIB

NHPMA = Northern Hardwood and Pine Manufacturers Association
SPIB = Southern Pine Inspection Bureau
WCLIB = West Coast Lumber Inspection Bureau
WWPA = Western Wood Products Association
(a) Southern red oak is not permitted.

C. **Marking.** Ensure that posts show the grading agency stamp indicating the mill origin, species, and grade.

D. **Dimensions.** Provide 7-foot-long line posts with a nominal 4-inch-square cross section or a round cross section with a diameter of at least 4½ inches.

Provide 8-foot-long end, corner, gate, intersection, and intermediate braced posts with a nominal 6-inch-square cross section or a round cross section with a diameter of at least 8 inches.

Provide mailbox posts at least 6 feet long with a nominal 4-inch-square cross section or a round cross section with a diameter of at least 4 inches.

E. **Dimensional Tolerances.** Provide round posts within +¾ inch and −¼ inch of the required diameter. Ensure that posts are equal to the required nominal length ±2 inches. Use the average top diameter to determine the sizes of posts that are not perfectly round. Provide square posts within −¼ inch of the required cross section.

F. **Decay.** Do not provide posts with butt rot in greater than 5% of the butt area. Ensure that post tops are sound, except that the Engineer may allow one pipe rot no greater than ⅜ inch in diameter in posts with a nominal top size of at least 6 inches.

G. **Knots.** Posts may contain sound knots trimmed flush with the post surface that do not affect the post strength.

H. **Crook or Bow.** Do not provide posts with short crooks, one-way sweep greater than 2 inches, and unsightly and exaggerated winding twists.

I. **Surface.** Provide fence posts that are peeled or shaved to remove the outer bark from the entire length. Shaving to remove the inner bark is not required.

   Completely remove the inner and outer bark from round posts for mailbox posts, guard posts, and guide posts.

J. **Preservative Treatment.** Condition and treat round posts, except northern white cedar, in accordance with AWPA U1, Section 6, Commodity Specification B, Use Category 4B (UC4B). Treat sawn posts as specified in subsection 912.05.C.

K. **Conditioning.** If air seasoned, stack posts in a Department-approved manner until the average moisture content is no greater than 19%.

L. **Preservatives.** Provide treatment preservatives meeting the requirements of AWPA U1, Section 4, “Standardized Preservatives (Informative)” and the relevant P Standards.

M. **Results of Treatment.** Refer to Table 912-3 for the minimum preservative penetration and retention as determined in accordance with AWPA standards.

Table 912-3:
Treatment Results Requirements: Preservative and Minimum Retention

Preservative	Minimum Retention 0.0–0.6 inch zone	AWPA Standard
Oil type	AWPA Commodity Specification B Table 3.1.2; use category 4B	A 6
Waterborne type		A 11
Minimum Penetration		
Species	**Heartwood**	**Sapwood**
Hardwoods and Douglas-fir	≥0.3 inch	0.6 inch or 90%, whichever is greater
Softwoods	—	2.0 inch or 90%, whichever is greater

912.08. Sawn Timber Posts and Blocks for Beam Guardrail and Highway Signs

A. **Species and Grades.** Provide wood posts for guardrail in accordance with Table 912-4; for wood blocks in accordance with Table 912-5; and for sign posts in accordance with Table 912-6. Ensure that the grading agency stamp is applied to the middle one-third of each sign post on the wider face.

Table 912-4:
Species and Grading Requirements for Sawn Timber Guardrail Posts

Species	Posts and Timber Grade	Grading Rules Agency
Hardwoods	Grade GRP	MDOT
Red oak (northern red, black, pin, laurel, cherry-bark, scarlet, water, and willow oaks)[(a)]		
Hard maple (black and sugar) and red maple		
White ash		
White-heartwood beech		
Yellow birch		
Hickory (mockernut, pignut, shagbark, and shellbark hickories)		
Softwoods		
Douglas-fir, Douglas-fir/larch	No. 1 or better	WWPA or WCLIB
Southern pine	No. 1 or better	SPIB
Jack pine 8 in × 8 in	No. 1 or better	NHPMA

(a) Southern red oak is not permitted.

Table 912-5:
Species and Grading Requirements for Sawn Timber Guardrail Blocks

Species	Blocks Grade	Grading Rules Agency
Hardwoods	Grade GRB	MDOT
Red oak (northern red, black, pin, laurel, cherry-bark, scarlet, water, and willow oaks)[(a)]		
Hard maple (black and sugar) and red maple		
White ash		
White-heartwood beech		
Yellow birch		
Hickory (mockernut, pignut, shagback, and shellbark hickories)		
Softwoods		
Douglas-fir and Douglas-fir/larch	No. 2 or better	WCLIB, WWPA
Southern pine species	No. 2 or better	SPIB
Jack pine, ped pine, and eastern white pine (northern white pine)	No. 1 or better	NHPMA

(a) Southern red oak is not permitted.

Table 912-6:
Species and Grading Requirements for Sawed Sign Posts

Posts	Species	Grade	Grading Rules Agency
4 × 6 inch (nominal) posts	Balsam fir	No. 1 (Joists-Planks)	NELMA
	Douglas-fir	No. 1 (Joists-Planks)	WCLIB
	Eastern hemlock	No. 1 (Joists-Planks)	NHPMA
	Tamarack (eastern larch)	No. 1 (Joists-Planks)	NHPMA
	Eastern white pine	Select Structural (Joists-Planks)	NELMA
	Southern pine	No. 1 (Joists-Planks)	SPIB
6 × 8 inch (nominal) posts	Douglas-fir	No. 1 Dense (Posts-Timbers)	WWPA
	Southern pine	No. 1 SR (Stress-Rated Timbers)	SPIB
	Eastern hemlock	Select Structural (Posts-Timbers)	NELMA
	Tamarack (eastern larch)	Select Structural (Posts-Timbers)	NELMA

For guardrails, provide wood posts and blocks with a nominal 6- by 8-inch cross section, except for jack pine provide at least No. 1 Grade posts with a nominal 8- by 8-inch cross section.

1. **MDOT Grade GRP.** Provide MDOT Grade GRP (guard rail posts) meeting the requirements of this subsection.

    a. **Splits.** Ensure splits are no greater than 3 inches on the bolt hole plane and no greater than 6 inches in other locations.

    b. **Checks.** Ensure single checks are no deeper than 3 inches. Ensure checks opposite each other do not have a total depth greater than 3 inches as measured with a probe no greater than $^{1}/_{16}$ inch thick and $^{1}/_{16}$ inch in diameter.

    Ensure single checks at least ⅜ inch wide, as measured at the widest point, do not extend along more than one-third of the post length.

    Ensure single checks, as measured at the widest point, are no greater than ⅜ inch wide.

    c. **Shakes.** Ensure shakes are no greater than 2 inches in the smallest dimension.

    d. **Splits, Checks, and Shakes.** Ensure splits, checks, or shakes do not appear in combinations that may cause posts to separate into pieces.

    e. **Stains.** Ensure pieces do not contain more than 25% stained heartwood, and staining is not caused by decay.

    f. **Slope of Grain.** Ensure that the slope of grain is no greater than 1:10.

    g. **Wane.** Ensure that wane occurs on less than one-quarter of any face.

    h. **Knots.** Ensure that knots are sound and tight. Ensure the sum of the least knot dimensions in 6-inch lengths of posts is less than 5 inches. Ensure that the grain distortion caused by knot clusters is no greater than 2½ inches. Ensure that knots do not exceed 2½ inches in the least dimension.

2. **MDOT Grade GRB.** Provide MDOT Grade GRB guardrail blocks meeting the requirements of this subsection.

    a. **Splits.** Ensure that splits are no greater than 3 inches on the bolt hole plane and no greater than 5 inches in other locations.

b. **Checks.** Ensure that single checks are no greater than 3 inches deep. Ensure that checks opposite each other do not have a total depth greater than 3 inches as measured with a probe no greater than $^1/_{16}$ inch thick and $^1/_{16}$ inch in diameter.

Ensure that single checks at least ⅜ inch wide as measured at the widest point do not extend along more than one-third of the post length.

Ensure that single checks, as measured at the widest point, are no greater than ⅜ inch wide.

c. **Shakes.** Ensure that shakes are no greater than 3 inches in the smallest dimension and do not extend more than one-half of the standard grading length.

d. **Splits, Checks, and Shakes.** Ensure that splits, checks, and shakes do not appear in combinations that may cause blocks to separate into pieces.

e. **Stains.** Ensure that pieces do not contain more than 25% stained heartwood, and staining is not caused by decay.

f. **Wane.** Ensure that wane occurs on less than one-third of any face.

g. **Knots.** Ensure that grain distortion caused by knot clusters is no greater than 4 inches. Ensure that knots do not exceed 4 inches in the smallest dimension.

B. **General Requirements**

1. **Decay.** Provide posts and blocks free from decay before treatment.

2. **Crook or Bow.** Ensure that crooks or bows are no greater than 1 inch per 10 feet of length.

3. **Dimensional Tolerances.** Provide posts and blocks with the following dimensional tolerances:

a. Cross-section within –½ of the required dimension;

b. Block length within –½ of the required length; and

c. Post length within –2 inches of the required length.

C. **Incising.** Incise Douglas-fir, western hemlock, and western larch timber posts before treatment to meet penetration and retention requirements. Incising blocks is not required. Ensure that the incisor has teeth a nominal ⅞ inch long to make cuts spaced 2½ inches apart lengthwise in rows ¾ inch apart. Ensure that alternate rows are staggered by 1¼ inches to

provide 60 diamond patterns of incisions per square foot. Ensure that the diamonds are 2½ inches long and 1½ inches wide from center to center.

As an alternative, the Contractor may incise posts in accordance with the American Railway Engineering and Maintenance-of-Way Association's *Manual for Railway Engineering*, Article 3.6.2.

D. **Inspection Before Treatment.** Inspect air dried or kiln dried material for moisture content as specified in subsection 912.09.E and in accordance with AWPA M2. Test representative pieces. Test at least 5% or 50 pieces out of a charge, whichever is less.

E. **Test for Moisture Content.** Test moisture content using an electrical resistance type moisture meter with insulated needles 1½ inches long. Correct readings for species and temperature readings in accordance with meter instructions. Take readings on one surface at mid length. Drive needles to their full length during readings. The Engineer will accept lots with average moisture content no greater than 19%. Remove individual pieces with moisture contents greater than 23%.

F. **Preservative Treatment.** Treat wood for guardrail posts and sign posts in accordance with AWPA U1, Section 6, Commodity Specification A, Use Category 4B. Treat wood for guardrail blocks in accordance with AWPA U1, Section 6, Commodity Specification A, Use Category 4A.

G. **Preservatives.** Provide preservatives meeting the requirements of AWPA U1, Section 4, "Preservatives for Pressure Treatment Processes," and the relevant P Standards.

H. **Sorting and Spacing.** Provide charges of the same species or species within any one group specified in Table 912-7. Provide material with a similar moisture content and similar form and size.

The Contractor may treat blocks and posts in the same charge after meeting the retention requirements specified in subsection 912.09.K. Use horizontal spacers to separate pieces in the charge to ensure that preservative and steam contact all horizontal surfaces.

Table 912-7:
Species Groupings for Treatment in Same Charge Group

Group	Species
A	Southern pine
B	Douglas-fir, balsam fir, eastern hemlock, tamarack
C	Jack pine, red pine, and eastern white pine
D	Hardwoods

I. **Conditioning.** Use air seasoning, kiln drying, Boulton drying, vapor drying, steaming, or heating in preservative.

Ensure average moisture content no greater than 19% for air seasoned or kiln-dried material before treatment.

If steam conditioning, do not exceed the maximum temperature specified in Table 912-8 in less than 1 hour. If applying a vacuum after steaming, ensure that the vacuum pressure is at least 22 inches of mercury. If using Chromated Copper Arsenate (CCA), Ammoniacal Copper Arsenate (ACA), or Ammoniacal Copper Zinc Arsenate (ACZA), remove the material from the cylinder and allow it to cool to no greater than 120°F after steaming and before applying the preservative. When treating Douglas-fir with pentachlorophenol, do not steam. If treating southern pine, jack pine, and red pine with CCA, ACA, or ACZA, use steam only to thaw frozen or ice coated material.

If conditioning material by heating in preservative, ensure that the solution covers the material. Refer to Table 912-8 for maximum temperatures. Do not condition by heating in water borne preservatives, including CCA, ACA, and ACZA.

Table 912-8:
Conditioning Methods and Temperature Requirements for Method Used

Species	Conditioning Methods Allowed	Steaming		Heating in Preservative	
		Max. Temp (°F)	Max. Duration (hour)	Max. Temp (°F)	Max. Duration (hour)
Hard maple	Air drying only, no steaming	—	—	—	—
Other hardwoods[a]	[b]	—	—	220	No limit
Southern pine	[b]	245	17	220	No limit
Eastern white pine	[b]	240	4½	210	6[c]
Other softwoods[d]	[b]	240	6	210	6[c]

(a) Red oak, white ash, white-heartwood beech, yellow birch, hickory, and red maple.
(b) See subsection 912.08.I.
(c) If using seasoned material; otherwise no limit.
(d) Jack pine, Douglas-fir, and red pine, balsam fir, eastern hemlock, tamarack

J. **Treatment.** Ensure that treatment meets the retentions and penetrations specified in subsection 912.08.K and subsection 912.08.L.

Apply pressure in accordance with Table 912-9. Maintain pressure until the required volume of preservative enters the wood.

For pentachlorophenol in Type A hydrocarbon solvent, do not exceed 210°F during the pressure period. For ACA, do not exceed 150°F during the pressure period. For CCA, do not exceed 120°F during the pressure period. For ACZA do not exceed 150°F during the pressure period.

If treating with pentachlorophenol, the Contractor may apply an expansion bath or a final steaming after completion of the pressure phase of the treatment, as specified in Table 912-9.

Table 912-9:
Pressure Requirements by Species

	Pressure (psi)		Preservative: Pentachlorophenol in Type A Hydrocarbon Solvent		
				Final Steaming[(a)]	
Species	Min.	Max.	Expansion Bath Max. Temp (°F)	Max. Temp (°F)	Max. Duration (hour)
Red oak	125	250	Not permitted	240	1
Other hardwoods	125	200	Not permitted	240	1
Jack pine, red pine	75	175	220	240	2
Southern pine	75	200	220	240	2
Douglas-fir Balsam fir Eastern hemlock Tamarack	50	150	220	240	2
Eastern white pine	50	135	220	240	1

(a) If using seasoned material, the Contractor may post-steam at 225°F for no greater than 15 hours.

K. **Retention.** Use chemical assay with samples taken after treatment as specified in subsection 912.09.M, and refer to Table 912-10 to determine the minimum retention for the outer 0.6 inch of guardrail posts, blocks, and sign posts using the specified AWPA standards. If treating blocks with posts, determine charge retention by assay of borings from posts.

L. **Penetration.** Refer to Table 912-11 for heartwood and sapwood penetration requirements. Take samples to determine penetration after treatment as specified in subsection 912.09.M.

Table 912-10:
Minimum Retention Requirements

Preservative	Minimum Retention (pcf)			AWPA Standard
	Guardrail Posts	Sign Posts	Blocks	
Pentachlorophenol	0.60	0.50	0.40	A6
CCA, ACZA	0.60	0.50	0.40	A11
ACQ[(a)]	0.60	Not allowed	0.40	A11
CA-B[(a)]	0.31	Not allowed	0.21	A11
CA-A[(a)]	0.31	Not allowed	0.15	A11
Other waterborne preservatives	AWPA Commodity Specification A, Table 3.0, Use Category 4B	Not allowed	AWPA Commodity Specification A, Table 3.0, Use Category 4A	A11

Notes:
ACQ = ammoniacal copper quaternary
ACZA = ammoniacal copper zinc arsenate
CA = copper azole
CCA = chromated copper arsenate
(a) Non-metallic washers or spacers are required for timber and lumber treated with ACQ or CA placed in direct contact with aluminum. Do not use with sign posts.

Table 912-11:
Penetration Requirements: Posts and Blocks

All Species Allowed[(a)]	Minimum Penetration	
	Heartwood	Sapwood
Guardrail posts and blocks	0.3 inch	0.6 inch or 90%, whichever is greater
Sign posts	0.5 inch	0.6 inch or 90%, whichever is greater

(a) For red oak, penetrate 65% of the total annual rings. If red oak cannot be penetrated as required, the Contractor may properly condition wood to refusal.

M. **Inspection After Treatment.** After treatment, examine the charge for cleanliness, mechanical damage, treatment damage such as severe checking, splitting, or honeycombing and for untreated areas resulting from air pockets, floating material, or insufficient preservative height. Remove defective material before shipment.

The Department will sample material in accordance with MTM 713 and test for preservative retention and penetration.

N. **Branding.** Permanently and clearly burn brand posts and blocks on one wide face. On guardrail posts, ensure that the brand is within 1 foot of the post top. On sign posts, ensure that the brand is within the middle

one-third of the post. Ensure that the brand shows the following information in accordance with AWPA M6:

1. Treater ID;
2. Plant designation;
3. Year of treatment (the month may be included);
4. Species or group (code designation specified in Table 912-12);
5. Preservative type; and
6. Retention type.

Table 912-12:
Group Coding as an Alternative to Species Coding

Group	Code[(a)]
Hardwoods	MH
Jack pine	J
Other softwoods	MS
Southern pine	SP
Douglas-fir	DF

(a) Species designated in Table 912-4, Table 912-5, and Table 912-6.

O. **Conformance.** Ensure that the treatment plant supplying the material provides a certificate indicating the species, grade, preservative type, retention, year, and name of treater.

P. **Degradation After Treatment.** Guardrail posts or blocks that develop at least one of the following before installation will be rejected:

1. Single checks at least 3 inches deep or checks opposite each other with a total depth greater than 3 inches as measured with a probe no greater than $^{1}/_{16}$ inch thick;
2. Single checks at least ¼ inch wide as measured at the widest point and extending along more than one-third of the length of the post or block;
3. Single checks greater than ⅜ inch wide as measured at the widest point;
4. Splits in the bolt hole plane greater than 3 inches long;
5. Crooks or bows greater than 1 inch per 10 foot length;
6. Twists; or

7. A combination of checks, splits, or shakes that may cause the post or block to separate into pieces.

Q. **Guardrail Offset Blocks.** The Contractor may select alternative materials for guardrail offset blocks from the Qualified Products List.

912.09. Timber for Rustic Construction

A. **Species and Grade.** Provide sound unfinished eastern or northern white pine, red pine, ponderosa pine, Douglas-fir, northern white cedar, or southern pine for logs, posts, timbers, lumber, and split rails for rustic construction.

Provide material free of decay with the bark removed. The Contractor may use salvaged rails from existing rail fences if the salvaged rails are sound and uniform in straightness and size.

B. **Shape and Dimensions.** Provide logs and posts with an average diameter, at the small end, of no less than the required diameter –¼ inch.

C. **Preservative Treatment.** Condition and pressure-treat wood for rustic construction in accordance with AWPA U1, Section 6, Commodity Specification B, Use Category 4A (UC4A), for above ground or Use Category 4B (UC4B) for ground contact.

D. **Preservatives.** Provide preservatives meeting the requirements of AWPA U1 Section 4, “Preservatives for Pressure Treatment Processes,” and the relevant P Standards.

912.10. Timber and Lumber for Human Conveyances

A. **Preservative Treatment.** Provide preservative treatment for timber and lumber on areas where frequent human contact may occur, including deck surfaces, walkways, handrails, steps, railing and fence posts, tables, and benches, with ammoniacal copper quaternary (ACQ) or copper azole (CA), in accordance with AWPA U1-20. Ensure that the ACQ preservative meets the requirements of AWPA P5. Do not use chromium copper arsenate (CCA) or other arsenic-based preservatives.

Ensure that the lumber and timber meet the preservative retention and penetration requirements of AWPA U1-20, Table 3.0 and Table 4.0, UC4A for aboveground and UC4B for ground contact.

For UC4A, ensure a retention of at least 0.40. For UC4B, ensure a retention of at least 0.60. Do not use wood species cited in Table 3.0 as “NR (Not Recommended) for ACQ preservative.”

B. **Results of Treatment.** Evaluate treatment results, including preservative analysis and penetration and retention, by testing chemical assay, in

accordance with AWPA A11. Process and treat wood in accordance with AWPA T1-04. Ensure that the preservative temperature during the pressure period does not exceed 150°F.

C. **Fasteners.** For wood treated with ACQ preservative, use stainless steel fasteners or hot-dip galvanized fasteners in accordance with ASTM A653/A653M, batch or post-dipped process, with a coating thickness of at least 1.85 ounces of zinc per square foot of surface area (G185). Do not mix fastener types. Ensure that aluminum does not directly contact ACQ-treated wood. Use non-metallic spacers if contact with aluminum may occur. Do not use aluminum fasteners.

Section 913. Masonry Units

913.01. General Requirements

Clay brick, concrete brick, concrete block, salvaged paving brick, precast reinforced concrete units, and structural tile for masonry structures must meet the requirements of this section.

913.02. Testing

Testing will be in accordance with the specified ASTM or AASHTO method as modified by this section.

913.03. Brick

A. **Brick Dimensions.** Brick must meet the following nominal size limitations:

1. Depth – 2 to 2½ inches;
2. Width – 3½ to 3¾ inches; and
3. Length – 7½ to 8 inches.

Brick for a single structure must be of one nominal size and must not vary from the manufacturer's specified standard dimensions by more than ±⅛ inch in any dimension. However, clay brick may vary in length by ±¼ inch, and up to 2% of the contract's clay brick quantity may exceed the dimensional tolerances.

B. **Clay Brick.** Clay brick to construct manholes, catch basins, and similar structures must meet the requirements of ASTM C32 for Grade MS.

Recessed or cored brick is acceptable.

Salvaged paving brick meeting the requirements of this section is acceptable.

C. **Concrete Brick.** Concrete brick must meet the requirements of ASTM C55 for concrete building brick.

Recessed or cored brick is acceptable.

D. **Sand-Lime Brick.** Sand-lime brick for masonry structures must meet the requirements of ASTM C73 for Grade SW and the following 5-hour boiling test water absorption requirements:

1. Average of five bricks – 18% maximum; and
2. Individual brick – 20% maximum.

913.04. Concrete Masonry Units for Structures Other than Drainage Structures

A. **Load-Bearing Units.** Hollow, load-bearing, concrete masonry units must meet the requirements of ASTM C90, Normal Weight.

B. **Non-Load-Bearing Units.** Hollow, non-load bearing, concrete masonry units must meet the requirements of ASTM C129, Normal Weight.

913.05. Concrete Block for Drainage Structures

Concrete blocks for manholes, catch basins, and inlets must meet the requirements of ASTM C139 except as modified by this subsection.

A. **Shape.** Block must be solid with parallel inside and outside surfaces, curved to the required radii, and must have a groove or other Department-approved joint at the ends.

B. **Size.** The block manufacturer will select the nominal block dimensions for length and height. Blocks must have a nominal width of 6, 8, or 12 inches, ±3%, as shown on the plans.

Where standard plans call for 12-inch-thick drainage structure walls, the Contractor may use two 6-inch-wide blocks to meet the required width. Blocks must be designed for length so that only full or half-length blocks are required to lay the circular wall of any one course.

The shape of blocks for use in the cones or tops of manholes or other structures must allow for constructing the structure as shown on the plans with inside and outside joints not to exceed ¼ inch in thickness.

913.06. Precast Reinforced Concrete Units for Drainage Structures

Circular precast concrete units with circular reinforcement for tops, risers, and sump bases for manholes, catch basins, and inlets must meet the requirements of AASHTO M199 and the following additions and exceptions:

A. Units must have the internal diameter shown on the plans and must accept standard covers.

B. The joint with the vertical wall of the structure must be the same design as the joints in the circular pipe sections to allow a uniform bearing on the full wall thickness of the pipe.

C. Construct openings for pipe inlets or outlets in the riser sections of drainage structures by blocking out the openings when casting the sections by scribing the openings in the green concrete and removing the green concrete from the openings or by drilling out the openings from cured concrete with a water-cooled diamond bit.

D. Openings in the riser sections must be 3 inches larger than the OD of the inlet or outlet pipe. The interior spacing between openings in a riser section must be at least 12 inches.

E. Obtain the Engineer's approval for the design of units for structure tops and for the design of sump risers with base units. Request approval for sump riser and base units used together.

913.07. Precast Concrete Bases for Drainage Structures

Precast concrete bases for drainage structures for sewers less than 48 inches in diameter must be cast with Grade 3000 or Grade 4000 concrete.

913.08. Structural Tile

A. **Load-Bearing Units.** Structural clay load-bearing tile must meet the requirements of ASTM C34 for Grade LBX.

B. **Non-Load-Bearing Units.** Structural clay non-load-bearing tile must meet the requirements of ASTM C56.

913.09. Precast Concrete Slope Paving Blocks

Blocks must have a compressive strength of at least 2,500 psi for an average of three units with no individual block having a compressive strength of less than 2,000 psi. The average water absorption of three units must be no greater than 10 pounds per cubic foot.

The Department will sample and test precast concrete slope paving blocks in accordance with ASTM C140/C140M with the following exceptions:

A. Test 4 by 4 inch compression test specimens sawn from precast concrete slope paving block units. The specimens will be tested with the load applied in the direction of the thickness of the unit.

B. Determine water absorption using half of the unit used for the compression test specimen.

Section 914. Joint and Waterproofing Materials

914.01. General Requirements

Joint and waterproofing materials for use in concrete construction must meet the requirements of this section.

914.02. Testing

Steel joint material testing must be in accordance with ASTM E8/E8M or ASTM A370 and the ASTM specifications applicable to the specific material.

Other joint and waterproofing material testing must be in accordance with the specified ASTM, AASHTO, or Department methods, as modified by this section.

914.03. Joint Filler for Concrete Construction

Cut joint filler into the shape and to the dimensions shown on the plans. Joint filler must not deform or break due to twisting, bending, or handling when exposed to atmospheric conditions. For concrete pavements, punch holes in the fiber joint filler for load transfer bars in new concrete pavements, as shown on the plans.

A. **Fiber Joint Filler.** Fiber joint filler must meet the requirements of ASTM D1751.

B. **Recycled Rubber Joint Filler.** Recycled rubber joint filler must meet the requirements of ASTM D1751 except that the minimum asphalt content does not apply.

C. **Closed-Cell Polypropylene Foam**. Semi-rigid, closed-cell polypropylene foam joint filler must meet the requirements of ASTM D8139.

914.04. Joint and Crack Sealants for Construction

A. **Hot-Poured Joint and Crack Sealant.** Hot-poured joint and crack sealant must meet the requirements of the Qualified Products List for Hot-Poured, Extra Low Modulus, Joint and Crack Sealant.

   Material containers must be legibly marked with a non-fading, weather-resistant ink or paint. Include the manufacturer's name or trade name, batch number, recommended pouring temperature, and the maximum safe heating temperature on the label.

B. **Backer Rod for Use with Hot-Poured Joint Sealant.** Backer rod for use with a hot-poured joint sealant must be solid, round, heat-resistant, closed-cell, cross-linked PE foam meeting the requirements of ASTM D5249 for Type I.

914.05. Joint Spall Repair Materials

Select joint spall repair material according to the contract.

914.06. Epoxy Resin Adhesive

Epoxy resin adhesive must be capable of being injected into, and flow along, a crack 0.005 inch wide. Select epoxy-resin adhesive from the Qualified Products List.

Use a fast-setting grout or fast-set temporary seal as recommended by the epoxy resin adhesive manufacturer.

914.07. Dowel Bars for Transverse Expansion and Contraction Joints

Dowel bars must meet the requirements of ASTM A1078/A1078M.

Provide dowel baskets from a Department-approved source. Secure the dowel bars into the baskets by welding or other mechanical method so the dowels maintain alignment during and after concrete placement.

The ends of dowel bars for expansion and contraction joints must be saw cut or sheared and free of burrs. If dowel bars are sheared, ensure that the ends remain round and do not deform. Dowel bars that are not free of burrs, deformation, or other surface defects will be rejected. Protect dowel bars during handling and storage according to ASTM A1078/A1078M.

A. **Coatings for Dowel Bars.** If required, provide dowel bars coated with an epoxy powder coating meeting the requirements of the Qualified Products List. The epoxy powder must be pigmented purple or gray.

   The Engineer may sample and test dowel bars for average coating thickness, and check for chips, cracks, or other damage to the coating and for the presence of a bond breaker, if required, before installation in the concrete construction. Dowels with coatings not meeting the thickness requirements or dowels with coating damage will be rejected.

   Epoxy-coated dowel bars must have an average coating thickness of not less than 0.010 inch or more than 0.014 inch on any bar, with individual determinations on a single bar within 0.004 inch of the average. Coating is not required on the end faces of the bars or on the cylindrical surface within 3 inches of the end fixed in the supporting basket by welding or other mechanical means.

   To prevent bonding to concrete, epoxy-coated dowels must be coated with an asphalt material meeting the requirements of MC 70 or RC 250, as specified in subsection 904.03.B, or an alternative bond-release agent selected from the Qualified Products List. Bond-release agents must provide a pull-out shear bond stress of the dowel bar no greater than

60 psi for initial and final movement of the dowel from the concrete specimen.

The Contractor or supplier may apply asphaltic coatings to the dowel bar and the dowel basket assembly. The manufacturer must apply the alternative bond-release agents to the dowel bar and the dowel basket assembly.

B. **Dowel Bar Expansion Caps.** Dowel bars for expansion joints must include metal or plastic expansion caps as shown on the plans and approved by the Engineer. Expansion caps must be sized to provide a slip fit onto the coated bar.

Expansion caps must have a uniform diameter for a length of at least 4 inches and must include a stop to ensure that the end of the cap remains at least 1 inch away from the end of the dowel bar during concrete placement. Fabricate metal expansion caps from at least 28-gauge sheet steel and close at the sides and end by crimping. Plastic expansion caps must be one piece with a uniform thickness of at least 1/16 inch, entirely closed on the end.

914.08. Devices for Transverse End-of-Pour Joints

Use straight steel tie bar devices for end-of-pour joints.

Straight tie bars for end-of-pour joints must consist of bars of the diameter and length shown on the plans meeting the requirements of ASTM A615/A615M, ASTM A706/A706M, or ASTM A996/A996M (Type R or Type A). Epoxy coat straight tie bars as specified in subsection 905.03.C except that the application of the epoxy coating within 4 inches of each end of the tie bar or the repair of damage to the coating within 4 inches of each end of the bar is not required.

914.09. Lane Ties for Longitudinal Pavement Joints

A. **Straight Tie Bars.** Straight tie bars for longitudinal pavement joints must consist of bars of the diameter and length shown on the plans meeting the requirements of ASTM A615/A615M, ASTM A706/A706M, or ASTM A996/A996M (Type R or Type A). Epoxy coat straight tie bars as specified in subsection 905.03.C except that the application of the epoxy coating within 4 inches of each end of the tie bar or the repair of damage to the coating within 4 inches of each end of the bar is not required.

B. **Bent Tie Bars for Bulkhead Joints.** Bent tie bars for bulkhead joints must consist of bars of the diameter and length shown on the plans. The tie bars must have a yield strength of at least 40,000 psi and be capable of withstanding bending to a 90° angle, re-straightening, and then

withstanding the pull-out test requirements specified in subsection 602.03.F.

Epoxy coat bent tie bars as specified in subsection 905.03.C except that the application of the epoxy coating within 4 inches of each end of the tie bar or the repair of damage to the coating within 4 inches of each end of the bar is not required.

914.10. Structure Expansion Anchors and Bolts

Select expansion anchors from the Qualified Products List in the sizes and shapes shown on the plans. Bolts for flush-type anchors must meet the requirements of ASTM A307 for Grade A.

914.11. Preformed Waterproofing Membranes and Joint Waterproofing

Select preformed waterproofing fabric system, including the manufacturer's recommended primer, from the Qualified Products List.

914.12. Elastomeric Bearings and Pads

A. **Bearings.** Elastomeric bearings must meet the requirements of the *AASHTO LRFD Bridge Construction Specifications*, Subsection 18.2, "Elastomeric Bearings," for 100% virgin polychloroprene (neoprene) or polyisoprene (natural rubber) bearings and must be classified as being of low-temperature Grade 4 or 5.

Laminated bearings must have a shear modulus of 100 psi ±15 psi. Plain bearings must have a shear modulus of 200 psi ±30 psi. Rolled steel sheet laminates must meet the requirements of ASTM A36/A36M or ASTM A1011/A1011M, Grade 36, Grade 40, or Grade 50. Blast-clean the surfaces of the laminates where elastomers are to be bonded.

Elastomeric bearings must be tested and accepted in accordance with Section 8 of AASHTO M251 except that the definition of a lot specified in Subsection 8.2 of AASHTO M251 is revised as follows: Sampling, testing, and acceptance consideration will be made on a lot basis. A lot of bearings must be considered to be a group of bearings that are manufactured over a 4-month period from the same elastomer recipe, cured under the same conditions, and type (plain, fabric laminated, or steel-laminated).

B. **Leveling Pads.** Elastomeric leveling pads (1/8 inch thick or as specified in the contract) must meet the requirements of the *AASHTO LRFD Bridge Construction Specifications*, Subsection 18.2, "Elastomeric Bearings," for 100% virgin polychloroprene (neoprene) or polyisoprene (natural rubber) bearings and must be classified as being of low-temperature Grade 3. Leveling pads must be plain elastomer and have a hardness between

50 and 70 on the Shore A scale. Provide certification to the Engineer that elastomeric leveling pads conform to this subsection.

Elastomeric leveling pads must be tested and accepted in accordance with Appendix X1 of AASHTO M251 except that a lot is defined to be material that is manufactured from the same elastomer recipe and cured under the same conditions and tested no less than once per year.

914.13. Non-Metallic Washers

Washers used as spacers between pin plates and link plates must be HDPE, non-metallic washers meeting the requirements of ASTM D4976, Group 2, Class 4, Grade 4.

Section 916. Erosion and Sedimentation Control Materials

916.01. Stone Used For Erosion and Sedimentation Control

Provide cobblestone, coarse aggregate 3×1, and riprap for erosion and sedimentation control on slopes, in ditches, and to construct erosion control devices, including check dams. Furnish natural stone that is sound, non-stratified, durable rock. Unless otherwise specified and not prohibited by permit, the Contractor may use sound pieces of broken concrete free of protruding reinforcement. Do not use crushed HMA pavement or broken brick as erosion and sedimentation control material.

A. **Cobblestone.** Furnish cobblestone that consists of rounded or semi-rounded rock fragments with an average dimension from 3 to 10 inches.

B. **Coarse Aggregate 3x1.** Furnish coarse aggregate 3×1 that meets the requirements of commercially graded material with particle sizes from ¾ to 3 inches.

C. **Riprap.** Furnish riprap that is natural stone, solid precast concrete blocks of Grade 3000 concrete, or sound pieces of broken concrete. Riprap must not contain soil. Randomly score the face of the precast concrete blocks to provide plane-of-weakness joints in sections with areas from 4 to 9 square feet. Lifting lugs, cast into concrete blocks, must not project above the finished concrete surface.

   The Department classifies riprap as plain or heavy, based on the horizontal cross section dimensions (“footprint” dimensions) and the in-place thickness of the individual pieces.

   1. **Plain Riprap.** Provide natural stone and broken concrete with footprint dimensions from 8 to 16 inches and an in-place thickness of at least 16 inches. The Contractor may use smaller pieces to fill spaces for better slope protection.

      Provide precast concrete block at least 6 inches thick with a surface area no greater than 15 square feet.

   2. **Heavy Riprap.** The smallest footprint dimension for natural stone and broken concrete must be at least 16 inches. The maximum-to-minimum dimension ratio must be no greater than 3:1. The in-place thickness must be at least 36 inches.

      Provide precast concrete block at least 16 inches thick with a surface area no greater than 20 square feet.

D. **Requirements for Specific Erosion and Sedimentation Control Applications**

1. **Checkdams.** Construct checkdams for ditches with grades less than 2% using cobblestone or broken concrete from 2 to 4 inches. Construct checkdams for ditches with grades 2% or greater using cobblestone or broken concrete from 3 to 10 inches.

2. **Stone Filled Bags.** Furnish coarse aggregate 6A, or open-graded aggregate 46G.

3. **Sand Filled Bags.** Furnish Class II granular material.

4. **Aggregate Cover.** Furnish dense-graded aggregate 21AA, open-graded aggregate 46G, coarse aggregate 6A, or coarse aggregate 3×1 produced natural aggregate, iron blast-furnace slag, reverberatory furnace slag, or crushed Portland cement concrete.

5. **Gravel Access Approach.** Furnish coarse aggregate 3×1, or as approved by the Engineer, that is produced from natural aggregate, iron-blast furnace slag, reverberatory furnace slag, or crushed Portland cement concrete.

916.02. Silt Fence

Geotextile for an erosion-control silt fence must meet the requirements of subsection 910.04.

Attach geotextile to machine-pointed, No. 2 common grade hardwood posts with at least five staples through wood lath at least ⅜ inch thick and 2.0 feet long. Maximum post spacing is 6½ feet.

Furnish posts at least 36 inches long with a cross sectional area of at least 2¼ square inches and a smallest dimension of 1½ inches.

Identify the fabricator with at least two permanent markings or affixed labels on each assembled roll of silt fence.

916.03. Temporary Plastic Sheet or Geotextile Cover

Mend or patch torn or punctured plastic sheets or geotextile cover with additional material of the same quality.

A. **Sheeting Material.** Furnish plastic sheeting material at least 6.0 mils thick with a UV ray inhibitor or PVC at least 10 mils thick. Use PVC material instead of plastic sheet from November 15 to April 1 or if expecting freezing conditions. Store and handle plastic sheet and PVC material in accordance with the manufacturer's recommendations. Do not expose sheeting material to heat or direct sunlight that would diminish strength or toughness.

B. **Geotextile Cover.** Geotextile cover must meet the requirements of subsection 910.03.A for geotextile blanket.

916.04. Inlet Protection Fabric Drop

Furnish geotextile silt fence fabric meeting the requirements of subsection 916.02 or geotextile blanket meeting the requirements of subsection 910.03.A. Furnish 34R or 6A for gravel filter berm.

916.05. Inlet Protection Geotextile and Stone and Drop Inlet Sediment Trap

Furnish geotextile blanket meeting the requirements of subsection 910.03.A. Furnish 34R, 46G, or 6A.

916.06. Sand Fence and Dune Stabilization

Furnish HDPE mesh fabric with a design opening of ½ to 1 inch. Minimum sand fence height is 4 feet.

916.07. Turbidity Curtain

Deliver turbidity curtain pre-assembled that includes the geosynthetic fabric, connection and securing mechanisms, flotation devices, stakes, and ballast chain.

A. **Geosynthetic.** Provide geosynthetic for turbidity curtain meeting the minimum physical requirements for stabilization geotextile that except permittivity must be no greater than 0.2 second^{-1} as specified by ASTM D4491/D4491M, and the trapezoidal tear strength must be least 50 pounds in accordance with ASTM D4533/D4533M.

The Contractor may use polymer-impregnated geosynthetics instead of meeting permittivity and opening size requirements.

Hemmed pockets to accommodate flotation devices and bottom weights must be sewn or heat bonded. Panel ends must include metal grommets through a reinforced hem. Tie connections between panels with synthetic or wire rope to prevent water flow through the joint.

B. **Flotation.** Furnish closed cell polystyrene flotation devices. Determine the required buoyancy based on site conditions. Flotation devices must ensure adequate freeboard to prevent overtopping.

C. **Stakes.** If using stakes to maintain curtain alignment, provide hardwood or steel stakes of lengths and cross sections capable of supporting the curtain. The Contractor may use external supports with embedment depths greater than 1½ feet. Maximum stake spacing is 6½ feet.

D. **Hardware.** Hardware, including stakes, ballast chain, connection bolts, reinforcement plates, and tension cables, must be galvanized, stainless steel, or aluminum and corrosion resistant. The mass of the ballast chain must be at least 0.7 pound per foot and be capable of maintaining the geosynthetic in a vertical position.

Section 917. Turf and Landscaping Materials

917.01. General Requirements

Nursery stock, seed, sod, mulching material, and chemical fertilizer nutrients must meet the requirements of this section. Provide documentation of inspection for plant diseases and insect infestation in accordance with state and federal laws.

917.02. Testing

The Engineer will require visual inspection or other acceptance tests of landscaping material as specified in this section or the MDOT's *Materials Quality Assurance Manual*.

917.03. Nursery Stock

Nursery stock must come from nurseries in Zone 4 or Zone 5 of the 2012 United States Department of Agriculture (USDA) Hardiness Zone Map for landscaping in Michigan's Lower Peninsula.

Nursery stock for landscaping in Michigan's Upper Peninsula must come from nurseries in Zone 3 or Zone 4.

Nurseries in Zone 6 of the Upper Great Lakes Region are allowed as follows:

A. At or north of latitude 40 degrees North;

B. Zone 6b includes only nurseries in counties that border the Great Lakes; and

C. Zone 6 plants are not acceptable for use in Upper Peninsula or in Lower Peninsula counties north of US-10 except for counties bordering Lake Michigan.

Nursery stock must meet the requirements of ANSI Z 60.1.

Nursery stock must be true to the type and name specified by the American Joint Committee on Horticultural Nomenclature's *Standardized Plant Names*. Label each plant type with the size, species, and variety. Include the common and scientific names on the label. Provide first-class quality stock with well-developed branch systems and vigorous, healthy root systems. Ensure uniform and straight tree trunks. Nursery stock grown in sandy soils or any damaged, diseased, under-developed, or infected plant material will be rejected. Provide trees, ornamentals, and shrubs as noted on the plans.

Notify the Engineer a minimum of 24 hours before stock delivery. Provide an invoice showing plant sizes, species, and varieties for each shipment. Plants will not be accepted until the stock is delivered and inspected at the project.

The Engineer may examine plants at the nursery by removing soil from the root systems of balled or container grown plants or by digging in the nursery row. The Department will not pay for plants that fail the Engineer's inspection.

A. **Deciduous Shade Trees.** Deciduous shade trees must be straight and symmetrical with a persistent, central main leader. The crown must be in proportion to the total height of the tree.

   Clumps must have at least two stems originating from a common base at the groundline.

B. **Small Trees, Ornamentals, and Shrubs.** Small trees, ornamentals, and shrubs must be well formed with a crown typical of each species or variety. Pruning, shearing, or sculpting plants to meet the sizes shown on the plans is not allowed.

C. **Evergreen Trees.** Evergreen trees must be typical of the species and not sheared or color treated. Do not use evergreen trees grown for Christmas trees. Antitranspirant protection for evergreen trees is allowed.

D. **Vines, Ground Cover, and Herbaceous Ornamental Plants.** Plants must be in individual containers, at least 1 year old, grown in pots long enough to ensure root growth capable of holding soil in place and retaining the container shape when removed from the pot. Vines must have at least four runners 1½ feet long. Leaf and stem structure of ground cover plants must be proportional to the root systems and typical of species or variety. Provide herbaceous plants in a heathy and vigorous growing condition.

917.04. Balling Material

Use untreated burlap as balling material. Do not use synthetic balling materials such as nylon or plastic.

917.05. Bracing and Guying Materials

A. **Wire.** For trees less than 4 inches in diameter, provide No. 11 galvanized steel guy wire. For trees with a diameter greater than 4 inches, provide No. 9 galvanized steel guy wire. Provide new wire free of bends and kinks.

B. **Hose.** Provide ¾-inch reinforced rubber garden hose or steam hose.

C. **Stakes.** Provide green metal T-section posts without anchor plates for bracing trees. For shade trees, the minimum post length is 8 feet. For evergreen trees, the minimum post length is 6 feet.

Provide nominal 2- by 4-inch stock stakes 24 inches long for guying plants. Stakes must be beveled on two or four sides to provide a point on one end.

917.06. Topsoil

The Engineer will review the topsoil testing report to determine whether it meets the organic matter, pH, gradation, and nutrient levels as stated in Table 917-1. Ensure that the topsoil is contamination-free and clean at the source prior to transport to the project site. Obtain the Engineer's approval for salvaged topsoil prior to use. Topsoil must meet the following requirements:

A. **Testing Reports**. Reports must contain at a minimum the following tests and the recommendation from the laboratory for amending the soil.

1. Mechanical gradation (particle size analysis);
2. Sand/Silt/clay content determined by hydrometer test of soil passing the No. 200 sieve;
3. Organic matter determined by an ash burn test or Walkley/Black test; and
4. Chemical analysis for nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, aluminum, lime requirements, and acidity (pH).

Table 917-1:
Topsoil Requirements

Requirement	Loam	Sandy Loam	Silty Loam	Clay Loam	Test Method
Passing ¾-inch sieve	100%	100%	100%	100%	ASTM D6913
Passing No. 4 sieve	>85%	>95%	>90%	>90%	ASTM D6913
Clay	10–30%	0–20%	0–25%	25–40%	ASTM D6913
Silt	30–50%	0–30%	50–90%	15–55%	ASTM D6913
Sand	25–65%	45–85%	0–50%	20–50%	ASTM D6913
Organic matter	3–10%	3–10%	3–10%	3–10%	ASTM D2974
pH	5.5–7.5	5.5–7.5	5.5–7.5	5.5–7.5	ASTM G51

917.07. Compost

The Engineer will review the compost test results to determine whether they meet the U.S. Composting Council's requirements. The Engineer will also visually inspect and approve the compost at the composting site for physical contaminants.

Compost must be mature, stabilized, humus like, and dark brown or black compost derived from the aerobic decomposition of yard clippings or other compostable materials as defined in the Natural Resources and Environmental Protection Act, Part 115, Solid Waste Management, MCL 324.11501 et seq., and federal laws. Compost must be certified through the US Composting Council's Seal of Testing Assurance Program and meet the following requirements:

A. Must be capable of supporting plant growth;

B. Must be free of objectionable odor, plastic, glass, metal, and other physical contaminants;

C. Must not contain viable weed seeds or other plant parts capable of reproducing with the exception of airborne weed species; and

D. Must not produce visible free water or dust during handling.

917.08. Peat Moss

Peat moss must consist of finely shredded sphagnum or fibrous peat moss of a Department-approved commercial grade, free of woody substance.

917.09. Fertilizers

Provide standard, commercial, packaged, or bulk product fertilizers in granular or liquid form. Each container of packaged fertilizer must be marked with the content analysis showing the minimum percentages of total nitrogen, available phosphoric acid, and soluble potash. If providing bulk fertilizer, provide an invoice with each shipment indicating the minimum percentages of total nitrogen, available phosphoric acid, and soluble potash.

A. **Landscape Fertilizers**

1. **Planting Fertilizers.** For mixing with peat moss and topsoil, provide ready-mixed granular fertilizer containing equal amounts of phosphorus and potassium by weight. Each cubic yard of prepared soil must contain chemical fertilizer to provide 1 pound of available phosphorus and 1 pound of available soluble potassium.

2. **Watering Fertilizers.** For application during watering, provide water soluble, nitrogen-enriched fertilizer containing 8.3 pounds of available nitrogen per 1,000 gallons of water.

B. **Seeding and Sodding Fertilizers.** Fertilizers in each class must contain a water-insoluble and water-soluble component.

1. **Class A.** Provide and apply as specified by this subsection and as indicated by soil tests:

a. **Water-Insoluble Fertilizer.** Apply 32 pounds of water-insoluble nitrogen per acre (e.g., 128 pounds of ureaform, 115 pounds of isobutylidene diurea). Provide the water-insoluble nitrogen from ureaformaldehydes, coarse grade isobutylidene diurea, or both.

b. **Water-Soluble Fertilizer.** Apply 48 pounds of nitrogen, phosphorous, and potassium nutrient per acre (e.g., 253 pounds of 19-19-19, 400 pounds of 12-12-12). Provide water-soluble fertilizer containing a 1:1:1 ratio of nitrogen, phosphorous, and potassium. Ensure that the fertilizer components include urea, diammonium phosphate, and potassium chloride.

2. **Class B.** Provide and apply as specified by this subsection and as indicated by soil tests:

a. **Water-Insoluble Fertilizer.** Apply 32 pounds of water-insoluble nitrogen per acre. Provide the water-insoluble nitrogen from ureaformaldehydes, coarse grade isobutylidene diurea, or both.

b. **Water-Soluble Fertilizer.** Apply nitrogen at a rate of 48 pounds of nutrient per acre and 40 pounds of potassium per acre. Ensure that fertilizer components include urea and potassium chloride.

3. **Class C.** Provide and apply as specified by this subsection and as indicated by soil tests:

a. **Water-Insoluble Fertilizer.** Apply 32 pounds of water-insoluble nitrogen per acre. Provide water-insoluble nitrogen from ureaformaldehydes, coarse grade isobutylidene diurea, or both.

b. **Water-Soluble Fertilizer.** Apply nitrogen at a rate of 48 pounds of nutrient per acre. Ensure that the fertilizer components include urea.

917.10. Water

Use water that meets the requirements of section 911.

917.11. Seed

Provide the required certified seed mixture as specified in Table 917-2. Select each species of seed from the Qualified Products List. Supply seed in durable bags with a tag marked by the manufacturer and supplier of the blended mix showing the species and variety name, lot number, net weight of contents, purity, and germination.

Table 917-2:
Seed Mixtures

Species	Minimum Purity (%)	Germination (%)	Seed Mixture Proportions (% by weight)							
			TDS	THV	TUF	TGM	THM	CR	TSM 6–24 months	TSM >24 months
Kentucky blue grass	98	85	5	15	10	10	30	—	—	—
Perennial ryegrass	96	85	25	30	20	20	20	—	50	50
Hard fescue	97	85	25	—	20	30	—	—	—	—
Creeping red fescue	97	85	45	45	40	40	50	—	—	—
Fults salt grass	98	85	—	10	10	—	—	—	—	—
Cereal rye	85	85	—	—	—	—	—	100	—	—
Spring oats	85	85	—	—	—	—	—	—	50	50

CR = cereal rye
TDS = turf dry sandy
TGM = turf medium to heavy soil
THM = turf loamy to heavy
THV = turf heavy soil
TSM = temporary seeding (months)
TUF = turf urban freeway

Seed must be tested in accordance with the *AOSA [Association of Official Seed Analysts] Rules for Testing Seeds*. The Engineer will evaluate deficiencies below the percentage required for purity and germination to determine acceptability.

917.12. Sod

Provide sod consisting of a densely rooted blend of at least two bluegrass varieties with at least 30% creeping red fescue content, free of weeds, and grown on the same or similar soil as the topsoil on the project. Obtain the Engineer's approval of the sod in the sod field before harvesting. Before cutting the sod, mow the grass to 3 to 4 inches above the ground surface.

Cut the sod from ½ to ¾ inch thick. If cutting sod into strips, cut in small uniform units of approximately 10 square feet per roll to ensure ease of handling of the sod without tearing or breaking. The sod may be cut, transported, and laid in large rolls with machinery designed for that purpose.

A. **Pegs for Sodding.** Provide pegs of sound wood, at least 10 inches long, with a cross-sectional area of at least 0.75 square inch for pegging sod. Use longer pegs in sandy or similar soils.

917.13. Mulching Materials for Nursery Stock

A. **Shredded Bark.** Provide shredded hardwood bark mulch consisting of tree bark stripped and shredded from saw logs with a debarking machine. Shredded hardwood bark mulch must be capable of passing through a conventional mulch blower. Do not use wood chips or recycled construction material.

917.14. Mulch for Seed

A. **Loose Mulch.** Provide clean, undamaged, and rot-free straw in an air-dry condition for loose mulch. Loose mulch must be free of weed seeds and other deleterious material.

B. **Turf Mulch Blankets.** Select turf mulch blankets from the Qualified Products List. Anchor according to the manufacturer's specifications. No metal stakes or staples are allowed.

1. **High-Velocity Mulch Blankets.** High-velocity mulch blankets must have net covering on two sides. The net must meet the requirements of subsection 917.14.D and be capable of reinforcing the blanket to prevent damage during shipping, handling, and installation.

    a. **High-Velocity Excelsior Mulch Blankets.** Provide high-velocity excelsior mulch blankets that meet the following requirements:

i. Blanket must consist of a uniform layer of interlocking excelsior fibers cut from sound, green timber;

ii. The average roll weight for an entire shipment must be 12 ounces per square yard ±10%;

iii. Blankets must be shipped in tightly compressed rolls; and

iv. Each roll must have the roll weight and the manufacturer's name written or stenciled on the roll wrapper or on an attached tag.

b. **High-Velocity Straw Mulch Blankets.** Provide high-velocity straw mulch blankets that meet the following requirements:

i. Blankets must consist of a uniform layer of clean wheat straw that is free of weeds and weed seed;

ii. When dry, the blankets must weigh 8 ounces per square yard ±10%;

iii. The straw and net must be stitched together to create a uniform mat;

iv. Blankets must be shipped in tightly compressed rolls; and

v. Each roll must have the roll weight and the manufacturer's name written or stenciled on the roll wrapper or on an attached tag.

2. **Mulch Blankets**

a. **Excelsior Mulch Blankets.** Provide excelsior mulch blankets meeting the requirements of high-velocity excelsior mulch blankets except that the blankets must weigh from 8 to 12 ounces per square yard and have netting on one side.

b. **Straw Mulch Blankets.** Provide straw mulch blankets meeting the requirements of high-velocity straw mulch blankets except that the blankets must have netting on one side.

C. **Mulch Anchoring.** Select mulch anchoring material from the Qualified Products List.

1. **Latex-Base.** Provide latex-base mulch-anchoring material composed of 48% styrene, 50% butadiene, and 2% additive by weight. The mulch-anchoring material must contain from 42.0 to 46.0% solids and a pH, as shipped, from 8.5 to 10.0. Protect the emulsion from freezing and prolonged exposure to sunlight.

2. **Recycled Newsprint.** Provide recycled newsprint mulch consisting of specially prepared, biodegradable, shredded, recycled newsprint fibers. The recycled newsprint fiber must:

    a. Have a moisture content (total weight) no greater than 12%;

    b. Have a high-grade newsprint content of at least 96% by weight (oven-dry);

    c. Include tackifier content from 1.5 to 3% by weight;

    d. Have a water-holding capacity of at least 32 ounces per 3.5 ounces of fiber;

    e. Contain a wetting agent and a defoaming agent; and

    f. Contain a nontoxic bright green or blue dyestuff that adheres to the fiber to minimize leaching of the color after application.

3. **Wood Fiber.** Provide specially prepared, biodegradable, air-dried, virgin wood fibers manufactured from 100% whole wood chips. Do not use recycled materials. The wood fiber must:

    a. Have a moisture content (total weight) no greater than 12%;

    b. Have an organic wood fiber content of at least 95% by weight (oven-dry);

    c. Include tackifier content from 3 to 5% by weight;

    d. Have a water-holding capacity of at least 35 ounces per 3.5 ounces of fiber;

    e. Be dyed with a green or blue biodegradable dye; and

    f. Contain no growth- or germination-inhibiting materials.

4. **Guar Gum.** Provide guar gum tackifiers consisting of at least 95% guar gum by weight with the remaining 5% by weight consisting of dispersing and crosslinking additives.

5. **Other Tackifiers.** Provide water-soluble natural vegetable gums, guar gums blended with gelling and hardening agents, or a water-soluble blend of hydrophilic polymers, viscosifiers, sticking aids, and other gums as tackifiers.

D. **Mulch Netting**

1. **Netting.** Provide mulch net with a mesh size from ½ by ½ inch to 1½ by 2 inches, formulated from or treated with a chemical that promotes the breakdown of the net within the first growing season

after placement. Mulch netting must be strong enough to hold the mulch in place and still deteriorate when exposed to sunlight.

2. **Net Anchors.** Provide wood or other biodegradable net anchors at least 6 inches in length. Do not use steel wire staples or pins to anchor mulch blankets or netting.

917.15. Weed Control

Provide herbicides registered for use on highway right-of-way by the Michigan Department of Agriculture & Rural Development and the United States Environmental Protection Agency. Obtain the Engineer's approval of herbicides prior to use. Do not use restricted-use herbicides.

917.16. Growth Preventive Material

Provide cut stump herbicide composed of the ingredients and nominal concentrations as appropriate.

A. **Upland Location**

1. 83% paraffin oil, surface active compounds, and coupling agents with blue colorant

   17% triclopyr, butoxyethyl ester

2. 82% paraffin oil, surface active compounds, and coupling agents with blue colorant

   15% triclopyr, butoxyethyl ester

   3% isopropylamine salt of imazapyr

B. **Wetland or Aquatic Location**

1. 100% triclopyr choline salt with blue colorant

Section 918. Electrical and Lighting Materials

918.01. Conduit

Provide nationally recognized testing laboratory labeled conduits with UV protection and manufactured for use at temperatures of at least 194°F unless otherwise required. For conduits encased in concrete, use Grade 3500 concrete. If steel reinforcement is required, provide reinforcement meeting the requirements of section 905.

Wall thickness and OD dimensions must conform to ASTM D1785 for smooth-wall Schedule 40 and 80 PVC conduit material. Maximum deviation from the minimum wall thickness is 3%.

Wall thickness range must be within 12% in accordance with ASTM D3035 for smooth-wall coilable Schedule 40 and 80 PE conduit.

A. **Galvanized Steel Conduit.** Provide nationally recognized listed and labeled galvanized steel conduit meeting the requirements of ANSI C80.1.

   Provide hot-dip galvanized couplings and fittings that meet the requirements of ANSI/NEMA FB1. Provide elbows and nipples meeting the requirements for conduit. Provide thread-type fittings and couplings for rigid conduit.

B. **Smooth-Wall Schedule 40 PVC Conduit.** Provide smooth-wall PVC conduit, fittings, and accessories manufactured from PVC meeting the requirements of ASTM D1784 and the applicable NEMA TC2 and UL 651 requirements.

C. **Smooth-Wall Schedule 80 PVC Conduit.** Provide smooth-wall PVC conduit, fittings, and accessories manufactured from PVC meeting the requirements of ASTM D1784 and the applicable NEMA TC2 and UL 651 requirements.

D. **Smooth-Wall Coilable Schedule 40 PE Conduit.** Provide HDPE Type III, Grade P 33, Category 5, Class C conduit meeting the requirements of ASTM D3485, ASTM D3350, and ASTM D1248.

   Mark conduit in accordance with ASTM D3485. Mark the conduit to indicate the producer code and designation, whether HDPE or Type III. Provide conduit produced from material with a color and UV stabilization code of C, D, or E in accordance with ASTM D3350. Provide black conduit for use above ground.

   For each project, supply a general certification that the PE conduit meets these requirements.

E. **Smooth-Wall Coilable Schedule 80 PE Conduit.** Provide smooth-wall, coilable, PE conduit meeting the requirements of applicable sections of NEMA TC7, UL 651 and 651A, and ASTM D3485.

Provide HDPE Type III, Grade P-33, Category 5, Class C conduit meeting the requirements of ASTM D3485, ASTM D3350, and ASTM D1248.

For each project, supply a general certification that the PE conduit meets these requirements.

F. **Rigid Fiberglass.** Provide filament-wound conduit and fittings consisting of E glass and corrosion-resistant epoxy resin, manufactured for use at temperatures from −40 to 230°F. Ensure that conduit is pigmented with carbon black for UV protection and fire resistant in accordance with UL 94. Provide heavy walled fiberglass conduit meeting the specifications, labeling, and testing requirements of ANSI/NEMA TC14.

918.02. Electrical Grounding System

Provide material for the electrical grounding system meeting the following requirements.

A. **Flexible Grounding Connection.** Provide flexible grounding connections made of flexible, flat, tinned copper braid with seamless tinned copper ferrules at each end. Provide flexible grounding connections with a minimum cross-sectional area equal to the cross-sectional area of the grounding cable. Provide ferrule capable of being formed to fit the curved surfaces of a clamp or pipe.

B. **Grounding Conductors and Bonding Jumpers.** Provide grounding conductors and bonding jumpers sized in accordance with the current National Electrical Code (NEC).

C. **Grounding Rod.** Provide a copper-clad steel grounding rod with a diameter of at least ¾ inch and a length of at least 10 feet, with no more than 10 ohms of resistance to ground.

D. **Connecting Hardware.** Provide silicon-bronze-connecting hardware meeting the requirements of ASTM B124/D124M. Provide materials supplied by the same manufacturer to ensure compatibility.

918.03. Electrical Conductors and Cable

Provide conductors and cable meeting the requirements of the NEC, the serving utility, and ASTM specifications. Provide nationally recognized, approved cable. Provide coated, soft drawn copper conductors in standard American Wire Gauge (AWG) sizes.

Provide conductors and cables with the size, voltage rating, insulation type, and manufacturer's name permanently marked on the outer covering at regular intervals. The manufacturer must provide splicing or terminating information for installation of the cable to the Engineer and Contractor.

A. **Overhead and Underground Service Conductors and Cable.** Provide cable consisting of three 1/C PE-insulated stranded conductors, assembled under a common PE jacket. Provide cables meeting the requirements of IMSA 20-1 for aerial and duct installation, except provide conductors of the required sizes and numbers. Single conductors rated for direct burial in a dedicated service conduit are permitted.

   Provide Periwinkle-type, or Department-approved equal, aluminum multiplex cable consisting of two sheathed conductors wrapped around a ground and messenger cable. Ensure that the phase conductor consists of seven-strand, No. 4 AWG with an insulation thickness of 45 mils. Provide a bare neutral messenger consisting of a 6/1 strand, No. 4 AWG, with a rated strength of 1,860 pounds.

B. **Traffic Signal Wire and Cable.** Provide stranded traffic signal wire and cable for aerial, underground duct or direct burial systems. Except for IMSA 51-5 cable, provide PE-insulated and PE-jacketed cables with 2 to 20 conductors. Provide IMSA 51-5 PVC insulated, nylon-jacketed cables loosely encased in a PE tube. Provide the sizes and number of conductors shown on the plans.

   Provide IMSA cable that meets the requirements of IMSA 20-1, IMSA 20-3, IMSA 20-5, IMSA 40-2 (aerial and duct), IMSA 40-4 (aerial self-supporting), IMSA 50-2 (loop lead-in), and IMSA 51-5 (loop) with the exceptions and additions specified in this subsection.

   1. **Conductors.** Provide concentric stranded, Class B, soft copper conductors meeting the requirements of ASTM B8 except do not allow joints in the conductors after completing final drawing operations.

   2. **Circuit Identification**. Provide color-coded insulation in accordance with the following:

      a. Table 5.1 of IMSA 20 1;

      b. IMSA 20 2;

      c. IMSA 20 5;

      d. Table 5.2 of IMSA 40 2; and

      e. IMSA 40 4.

      Do not print numerals or words on the insulation for conductor identification.

C. **Messenger Cable**. Provide stranded, ¼ inch, Class C, galvanized, extra-high-strength steel strand messenger cable of no more than seven-wire meeting the requirements of ASTM A475, as specified by 9.1-A of IMSA 20-3 and 11.1 of IMSA 40-4.

918.04. Direct Burial Cable and Conductors

Install direct burial cable and conductors in conduit unless otherwise shown on the plans.

Direct burial cable and conductors in conduit for use in wet locations must be a type allowed in the current NEC for direct burial.

Unless otherwise required, provide nationally recognized listed cables rated at 600 volts. Provide cables and conductors resistant to oils and chemicals, rated 194°F dry and 167°F wet, for installation in wet and dry locations exposed to the weather and meeting the requirements of UL 44.

Provide cables for electric service entrance runs with a USE rating.

For all individual conductors, provide type RHW/USE.

A. **Conductors.** Provide uncoated, copper, UL 44 approved conductors meeting the requirements of ASTM B3. Provide Class B conductors stranded in accordance with ASTM B8. Ensure that the manufacturer's insulation curing process does not damage uncoated conductors.

Color code the insulation on conductors No. 2 AWG and larger. Field tape at least 12 inches of conductors ends with half-lapped color tape. Use colors as described in the next paragraph.

Use conductors with colored insulation for sizes smaller than No. 2 AWG. Color code neutral conductors white for 240/120-volt systems and gray for 480/277-volt systems. Color code a single-phase 3-conductor with one black conductor, one red conductor, and one white conductor for a 120/240-volt system. Color code a single-phase 2-conductor with one brown conductor and one orange conductor for a 480-volt system. Color code a single-phase 2-conductor with one black conductor and one white conductor for a 120-volt system. Color code a single-phase 3-conductor with one brown conductor, one orange conductor, and one gray conductor for a 480/240-volt system. Color code a three-phase 4-conductor with one brown conductor, one orange conductor, one yellow conductor, and one gray conductor for a 480/277-volt system.

918.05. Equipment-Grounding Conductor

Provide insulated or bare copper conductors meeting the requirements of ASTM B3 for equipment-grounding conductors. Provide equipment-grounding conductors that are stranded in accordance with ASTM B8 for Class B. For

installing conductor in conduit, insulate and color code the conductor green. For installing in earth, keep the conductor bare.

918.06. Handholes

A. **Concrete.** Provide Grade 3500 concrete.

B. **Steel Reinforcement.** Provide bar or welded cage mesh steel reinforcement capable of supporting HS-20-44 loading. Provide reinforcement as shown on the plans or in accordance with the manufacturer's design. If reinforcement deviates from the plans, provide calculations showing that the new design supports HS-20-44 loading.

C. **Frame and Covers.** Provide frame and covers of steel and classified as light duty or heavy duty. Provide covers with the required logo in the location and of the size specified on the handhole detail sheet.

1. **Light-Duty Cover.** Provide East Jordan No. 2982A-18 or Neenah Foundry No. R-6012-D round cover or a Department-approved equal.

2. **Heavy-Duty Cover.** Provide East Jordan No. 2860A or Neenah Foundry No. R-6052-D round cover or a Department-approved equal.

D. **Polymer Concrete Handhole Boxes and Covers.** Construct handhole boxes of polymer concrete, reinforced with a heavy weave fiberglass.

Provide heavy-duty enclosures and covers designed and tested to −50°F with a compressive strength of at least 11,000 psi. Provide covers with a friction coefficient of at least 0.5.

1. **Boxes.** Provide stackable, heavy-duty, nominal 17- by 30- by 12-inch handhole boxes, rated for 5,000 pounds over a 10- by 10-inch area.

2. **Covers.** Provide handhole covers with a service load of at least 15,000 pounds over a 10- by 10-inch area. Provide covers marked with a logo as required. Secure covers with stainless steel, 300 series, ⅜ inch, 16NC hex bolts and washers.

E. **Handhole, Square, 4 foot.** Construct handholes from concrete.

1. **Handhole.** Provide handholes with live loads meeting the requirements of AASHTO HS 20-44 for heavy traffic. Increase the handhole design live load by 20%, given an earth cover from 2 to 5 feet.

Provide standard telecommunications Type S precast handholes with inside dimensions of at least 48 by 48 by 48 inches.

Center the top opening in the roof of the handhole and provide at least a 39-inch-diameter clear opening. Provide eight bell end inserts in the

sides for a 4-inch PVC conduit. Provide a knockout for one 14-inch-diameter sump crock in the base of the handhole.

Provide a handhole that is watertight to within 42 inches of grade. Ensure that the manufacturer provides master sealer for joints and holes including grade rings and pull-in irons.

Provide one 12-inch, interlocking, grade ring with a galvanized step cast into the ring. Provide a grade ring with an OD of at least 45 inches and an inside diameter of 39 inches ±1 inch.

Cast metal bolt anchor inserts for ½-inch bolts into each wall. Ensure that spacing between inserts is no greater than 24 inches. Protect the inserts during casting to prevent filling with concrete.

2. **Hardware.** Provide metallic hardware that is hot-dip galvanized or stainless steel. Provide a complete hardware package with each handhole including the following:

   a. One hook ladder for hooking on the step of the grade ring when positioned at the climbing angle;

   b. Four pull-in irons with backing plates;

   c. Eight 36-inch cable racks (Underground Devices No. CR36 or Department-approved equal); and

   d. Sixteen 3-inch throat saddle (Underground Devices No. 3HDS or Department-approved equal).

3. **Frame, Ring, and Cover.** Provide a heavy-duty cast-iron frame, grade ring, and cover manufactured by East Jordan Iron Works or a Department-approved equal. Provide a Model 1220C ring and cover with “Signals & Lighting” cast into the cover. Do not use other ring and cover model numbers. Provide a frame weighing 410 pounds and a cover weighing 245 pounds.

F. **Handhole, Round, 3-foot diameter.** Construct handhole boxes from concrete.

1. **Handhole.** Provide handholes with live loads meeting the requirements of AASHTO HS 20 for wheel loading.

   Ensure that concrete attains a 28-day compressive strength of at least 4,500 psi.

   Provide smooth or deformed welded wire fabric in accordance with ASTM A1064/A1064M.

   Provide reinforcing steel meeting the requirements of ASTM A615/A615M for Grade 60 rebar if required. Bend bars and place in

accordance with the latest American Concrete Institute (ACI) standards.

Provide precast handholes with the following characteristics:

a. Inside diameter of 36 inches, capable of accommodating round covers;

b. Integral wall and base;

c. Height of 44 or 48 inches;

d. OD of 44 inches;

e. One 6-inch knockout in the base for a sump drain hole; and

f. Walls with four tapered knock-outs for conduit entering the handhole, 2 inches deep from the inside and 10 to 11 inches in diameter.

Construct the handhole to accept a heavy-duty frame and cover centered atop the handhole.

2. **Frame and Cover.** Provide a heavy-duty cast-iron frame, grade ring, and cover manufactured by East Jordan Iron Works or a Department-approved equal. Provide a Model 1220 ring and cover with required logo cast into the cover. Do not use other ring and cover model numbers. Provide a total assembly weighing 675 pounds.

918.07. Light Standard Foundation

A. **Concrete.** Provide Grade 3500 concrete.

B. **Steel Reinforcement.** Provide steel reinforcement as shown on the plans and meeting the requirements of section 905. When reinforcement meets the requirements of the NEC, it must be used for grounding.

C. **Anchor Bolts, Nuts, and Washers.** Provide anchor bolts, nuts, and washers meeting the requirements of subsection 908.14.

Provide anchor bolts with a diameter of at least 1 inch with series 8UN threads. Provide anchor bolts threaded 4 inches beyond the anchor bolt projection shown on the plans.

D. **Ground Rods.** Use a ground rod meeting the requirements of subsection 918.02.C.

1. **Grounding Electrode Conductor.** Provide No. 6 stranded, bare copper, grounding-electrode conductor for the street lighting unit meeting the requirements of subsection 918.02.B.

2. **Conduit.** Provide conduit in the foundation to allow placement of conductors and grounding wires as shown on the plans and meeting the requirements of subsection 918.01.

918.08. Light Standards

Provide steel, aluminum, or other light standard material. Provide light standards designed in accordance with AASHTO's *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*. Use a wind importance factor based on a recurrence interval of 50 years for the design wind speed. Do not use alternative methods of determining wind speed. Use a Category I fatigue importance factor. Submit calculations for the light standard design, sealed by a Professional Engineer who is licensed in the State of Michigan, to the Engineer for approval.

A. **Steel Light Standards**

1. **Shafts.** Provide light standard shafts of hot-rolled, low-carbon steel or high-strength, low-alloy steel. Provide shafts with a tensile yield strength of at least 50,000 psi when tested before or after fabrication.
2. **Handhole.** Provide light standards with reinforced handholes with a steel cover and a grounding nut or lug inside the shaft. Ensure that the grounding nut or lug is easily accessible from the handhole.
3. **Anchor Bases.** Provide one-piece anchor bases of cast steel or hot-rolled steel plate. Cast steel anchor bases must meet the requirements of ASTM A27/A27M for Grade 65-35, and hot-rolled steel plate anchor bases must meet the requirements of ASTM A36/A36M.
4. **Bracket Arm Assembly.** Provide a bracket arm assembly of truss-type design and steel meeting the requirements of ASTM A53/A53M Grade B or ASTM A36/A36M. Ensure that the installed bracket arm assembly provides a weather-resistant connection with a smooth wiring raceway.
5. **Hardware.** Provide American Iron and Steel Institute (AISI) Series 300 stainless steel threaded fasteners and lock washers to secure parts to the shaft.

B. **Aluminum Light Standards**

1. **Shafts.** Provide round, octaflute, or octagonal aluminum shafts with a uniform taper.

   Provide a shaft fabricated from a single piece of seamless tubing of aluminum alloy 6063 meeting the requirements of ASTM B221.

After fabrication, ensure that the shaft has physical strength properties meeting the requirements for T6 temper.

Provide aluminum alloy 356-T6 castings except for the shaft top, provide aluminum alloy 43F.

Provide sand castings meeting the requirements of ASTM B26/B26M. Provide permanent mold castings meeting the requirements of ASTM B108/B108M.

2. **Handhole.** Provide light standards with a reinforced handhole, an aluminum cover, and a grounding nut or lug inside the shaft. Ensure that the grounding nut or lug is easily accessible from the handhole.

3. **Bracket Arm Assembly.** Provide a bracket arm assembly of truss-type design and aluminum alloy pipe or tapered tubes. Ensure that the installed bracket provides a weather-resistant connection with a smooth wiring raceway.

   Provide pipes meeting the requirements of ASTM B241/B241M for aluminum alloy 6063-T6 or 6061-T6.

   Provide tapered tubes meeting the requirements of ASTM B221 for aluminum alloy 6063-T6 or 6061-T6.

4. **Hardware.** Provide aluminum alloy 2024-T4 or AISI Series 300 stainless steel threaded fasteners, lock washers, and other pieces to secure parts to the shaft.

C. **Frangible Transformer Bases.** Provide frangible transformer bases selected from the Qualified Products List.

D. **Anchor Bolts.** Provide galvanized anchor bolts, studs, nuts, couplings, and washers in accordance with subsection 908.14.

918.09. Luminaires

Use luminaires per the contract.

918.10. Tower Lighting Unit

Provide tower lighting units designed in accordance with AASHTO's *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*. Use a wind importance factor for the design wind speed based on a recurrence interval of 50 years. Do not use alternative methods of determining the wind speed. Use a Category I fatigue importance factor. Base design calculations on a yield strength of no greater than 50,000 psi.

A. **Shaft.** Provide steel shaft material from a single thickness steel sheet with no laminations. Shaft material must meet the requirements of ASTM

A1011/A1011M, Grade 50, with a silicon content no greater than 0.060% or a silicon content from 0.150 to 0.250%.

Provide shafts with an overall diameter of at least 23½ inches at the base with uniform taper to the top to a diameter of at least 6 inches. Shafts must have a minimum wall thickness of $^{3}/_{16}$ inch.

1. **Handhole.** Provide shafts with hinged doors fabricated from the same material as the shafts. Provide doors at least 24 by 14 inches. Provide doors with a hasp for a padlock. Place access holes so they do not intersect the longitudinal seam weld on the pole.

B. **Anchor Base.** Provide steel base material from a single thickness steel sheet with no laminations. Base material must meet the requirements of ASTM A572/A572M, Grade 50, with a silicon content of no greater than 0.060% or a silicon content from 0.150 to 0.250%.

C. **Anchor Bolts, Nuts, and Washers.** Anchor bolts, nuts, and washers must meet the requirements of subsection 908.14.

D. **Head Frame Assembly.** Provide a head frame assembly with a pair of pulleys for each stainless steel cable located to support the luminaire ring. Provide a roller assembly or a single pulley for the power cord. Provide a hoisting system with two or three stainless steel cables at the head frame assembly.

1. **Power Cord Roller Assembly.** If using a roller assembly to support the power cord, provide six rollers mounted between two cold-rolled steel plates that are zinc-electroplated in accordance with ASTM B633 and yellow chromatic-dipped. Ensure that the power cord rides on rollers of acetate resin mounted on AISI 304 stainless steel shafts. Locate the six rollers to support the power cord in a bending radius of at least 7 inches. Except for pulleys and rollers, fabricate parts of the assembly from ASTM A572/A57M Grade 345 steel.

   Design the assembly to protect parts from the weather.

2. **Power Cord Pulley.** If using a pulley to support the power cord, provide pulleys fabricated from a single piece of galvanized steel with a diameter of at least 16 inches.

3. **Pulleys for Stainless Steel Support Cables.** Provide pulleys with a minimum diameter of 6 inches fabricated from one piece of stainless steel or galvanized steel.

   Provide pulleys with permanently lubricated bronze bearings and stainless steel axle pins. Ensure that the depth of the vee on pulleys is equal to or greater than the diameter of the cable. Provide guards to prevent cables from riding off the pulleys.

4. **Latching.** The Contractor may locate the latching mechanism for the luminaire mounting ring at the head frame assembly or at the base of the pole.

   If the latching mechanism is at the head frame assembly, provide three latches as an integral part of the head frame assembly. Latch the luminaire mounting ring by the alternately raising and lowering of the luminaire ring assembly using the winch and hoisting assembly. Attach moving parts of the latching mechanism to the luminaire ring assembly. Ensure that the moving parts are serviceable at ground level. Ensure that the luminaire ring does not move horizontally or rotate around the pole during the latching or unlatching process. Use indicator flags, visible from the ground, to signal the latching and locking of each latching mechanism.

   If using a two-cable hoist system, provide for the latching of the luminaire mounting ring at the base of the pole. Provide a cable anchoring device to latch each supporting cable in place.

E. **Luminaire Mounting Ring.** Provide a luminaire mounting ring capable of supporting 2-inch-diameter mounting tenons, complete with ballasts, evenly distributed around the ring for mounting the required number of luminaires. Ensure that the luminaire mounting ring provides a raceway or enclosure for the required electrical connections to the luminaires.

   Provide the mounting ring with at least No. 12 AWG copper wire rated at 200°F.

   Provide a galvanized steel luminaire mounting ring and related components. Galvanize in accordance with ASTM A123/A123M after fabrication.

   Equip the luminaire mounting ring with a weatherproof male receptacle to energize the luminaires in the lowered position. Ensure that connections are weathertight and protected when the luminaires are in the operating position.

   Make provisions for centering and damping contacts that the luminaire mounting ring may encounter while ascending and descending the pole.

   Provide roller-contact with spring-loaded centering arms on the luminaire mounting ring. Ensure that the luminaire ring centering device maintains the ring concentric with the pole.

F. **Luminaires for Tower Lighting.** Provide luminaires capable of operating at mounting heights greater than 100 feet. Provide luminaires capable of withstanding wind velocities of 120 feet per second and resulting vibrations. Provide a luminaire that weighs no more than 94 pounds.

When mounted in the operating position, ensure that an area no greater than 5.4 square feet is exposed to the wind.

Provide luminaires meeting the requirements specified by the following:

1. **Housing**. Provide a structurally rigid luminaire housing of cast or formed aluminum with a copper content no greater than 0.2%.

   Provide a housing containing an integral slip fitter mounted on a 2-inch pipe bracket or a 1½-inch pipe bracket with inserts.

   Provide a mechanical means to limit insertion of the pipe arm. Provide a mechanical means for leveling the luminaire to within a range of ±3 degrees from the horizontal.

   Provide a leveling surface on the housing exterior to mount the luminaire in the operating position. For luminaires producing asymmetrical light distributions, orient to distribute the light as shown on the plans. For exposed exterior hardware and fasteners, provide stainless steel, Monel metal, or aluminum alloy hardware and fasteners. For the luminaire-to-bracket arm-mounting fasteners and other internal fasteners, provide stainless steel or zinc-coated steel fasteners. Provide remaining internal hardware of stainless steel, aluminum alloy, or zinc-coated steel.

2. **Reflector.** Provide aluminum or glass reflectors affixed to the refractor or the cover glass with a gasket. Provide extruded silicone rubber or synthetic fiber felt gaskets.

3. **Aluminum Reflector.** Provide enclosed aluminum reflectors fabricated with ALGLAS reflector finish or a sealed anodic coating over an electrolytically or chemically brightened specular surface. Provide optical parts that are weathertight and bug tight. Provide a coating that is at least 4 milligrams per square inch in accordance with ASTM B137. Provide a coating seal meeting the requirements of ASTM B136. The fabricator must submit certification that the reflector coating meets requirements upon the Engineer's request.

4. **Glass Reflector.** Provide one-piece, clear borosilicate glass reflectors free of bubbles and ripples. Protect the reflector back surface from the effects of atmospheric oxidation and moisture.

5. **Cover Glass.** Provide clear tempered cover glass. Mount the cover glass to the holding ring but allow for easy replacement.

   Use an ethylene-propyleneteroplymer or synthetic fiber felt gasket for the cover.

6. **Ballast**. Mount the ballast or ballast housing on the luminaire housing. Ensure that the ballast, ballast housing, and luminaire housing are entirely enclosed. Install a gasket between the ballast housing and luminaire housing. Provide ballasts designed to operate at the rated voltage shown on the plans.

   Identify the ballast lamp wattage and circuit voltage in accordance with ANSI C 82.4.

   Provide a regulating auto-transformer-type ballast. Ensure that an applied primary voltage change of ±10% of line nominal at the ballast does not cause more than a ±13% change in lamp wattage. Ensure a power factor of at least 90% at the rated voltage. Provide a ballast that starts reliably at −20°F with ±10% of line nominal voltage variations.

7. **Lamp.** Provide lamps of the type and size shown on the plans.

8. **Socket**. Provide a socket assembly of rigid construction to ensure that the lamp retains the required position during service. Do not use socket adapters for positioning lamps.

   Provide nickel-plated brass sockets with a porcelain covering. Provide a socket with lamp grips. Provide a socket with a spring-loaded center contact. Weld or attach sock leads with crimp-type, solderless, compression connectors.

   If the socket is capable of variable socket positions, provide information to establish the correct socket position.

9. **Wiring**. Complete internal wiring and connections so only incoming supply conductors require attachment to pressure-type connectors on a terminal block.

   Provide a terminal block rated at 600 volts and meeting the requirements of the NEMA ICS 4-2015. Provide a terminal board that accommodates crimp-on, solderless, compression connectors for interior wiring.

   Mechanically and electronically fasten the incoming supply conductors with compression terminals to accommodate wire from No. 12 to No. 16 AWG.

10. **Fusing.** Provide and mount inline FNM-type fuses in the luminaire housing. Provide fuses with the current ratings in Table 918-2.

Table 918-2:
Current Ratings per Circuit Voltage

Circuit Voltage	Current Rating
120 volts	30 amperes
240 volts	15 amperes
277 volts	15 amperes
480 volts	15 amperes

11. **Painting.** Paint the luminaire housing metallic gray.
12. **Packaging.** Pack luminaires individually for shipment.
13. **Assembly Drawings.** Provide assembly and installation drawings.
14. **Sampling and Testing.** Provide test data certification for tower lighting luminaires.

G. **Lowering Device.** Equip the inside of each tower lighting unit with an electric motor and a hoisting device capable of raising the required number of luminaires plus 300 pounds to the operating position and lowering the luminaires to 5 feet above the foundation. Ensure that raising and lowering operations can be controlled 15 feet from the pole base. The Contractor may use a transformer to obtain the desired voltage of the motor for remote operation.

Provide a lowering device with a worm gear, a gear reducer hoist of at least 30:1 and supporting, hoisting, and electric cables to the luminaire mounting ring.

Mount the device inside the pole base with stainless steel hardware. Provide the hoist drum with a stainless steel cable at least ¼ inch in diameter, attached to the hoist drum and long enough for at least one complete layer on the drum plus the length required to lower the luminaire mounting ring to the lowest position.

If using a single hoisting cable, provide a cable junction plate to join the three supporting cables to the hoisting cable and to hold the lower end of the electric cable. Ensure that the junction plate is accessible through the handhole when the luminaire mounting ring is in the raised position. Provide three stainless steel supporting cables $^{3}/_{16}$ inch in diameter. Provide means to adjust the length of each of the three supporting cables by 4 inches with the luminaire mounting frame at the top of the pole. As an alternative, the Contractor may provide for each of the three supporting cables to terminate through a coil spring under compression so when the luminaire mounting ring is in the raised position, differences in tension of one or two cables will compensate for a difference of 3 inches in the length of those cables.

H. **Electric Cable.** Provide portable power cable Type W-4, round, 600-volt, No. 8 AWG, copper electrical cables with 133 strands in each conductor, rated at 167°F. Provide cable that meets the requirements of ICEA S-19-81.

Provide the same type of cable for the electric supply from the safety switch to the terminal block in the pole and from the terminal block to the twist-lock connector. Ensure that the cable reaches through the handhole in the pole to serve as a power source for the electric drill or motor to operate the lowering device.

Where the electric cable attaches to the cable junction, provide a strain relief grip to hold the electric cable. Provide a strain relief grip that has an insulated compression-type connector capable of supporting the cable when the luminaire mounting ring is lowered. Where the electric cable connects to the luminaire mounting ring, provide a similar strain relief grip to hold the other end of the electric cable.

I. **Lightning Arrestor.** Mount a lightning arrestor with the necessary operating voltage and conditions inside the pole base. Ensure that the lightning arrestor is accessible through the handhole and connected between the load side of the fused safety switch and the pole grounding lug by the shortest practical connections.

J. **Twist Loc Connector.** Provide a 600-volt, nationally recognized listed 50 ampere, three-pole, 4-wire, twist-type connector. Provide a power cord from the luminaire mounting ring with a male plug and a supply cord with a female plug.

K. **Electric Drill/Motor.** Provide an electric drill or motor to operate the hoisting device. If using an electric drill, provide a 240-volt, heavy-duty, industrially rated, ½-inch capacity, electrically reversible electric drill with special chuck to fit the lowering device hoist. Provide an electric drill with a special mounting bracket for attaching to the hoist through the handhole in the pole.

If using an electric motor, use a reversible, standard frame motor with a magnetic brake.

Mount the drill or motor frame so it is connected to the hoist without being held by other means. Provide a drill or motor that operates the hoist in either direction from the mounted position.

Provide a flexible electric cord with heavy-duty 600-volt insulation for the drill or motor and an attachment plug that fits the 240-volt outlet in the metal pull box. Provide a momentary push-button control in the electric cord for the drill or on a separate cord from the drill to allow operation of

the drill in either direction or stopping when the operator is as far as 15 feet from the pole.

Provide a test cable with the drill or motor to energize the luminaires when the mounting ring is in the lowered position. Provide the same type cable as the electric cable up the pole. Provide a cable that includes the required fittings and length to connect the electric supply to the weathertight outlet in the luminaire frame.

L. **Foundation.** Construct the foundation for the tower lighting unit as shown on the plans. Ensure that the pole manufacturer provides the anchor bolts for installation in the foundation.

Provide each anchor bolt with two nuts for plumbing the pole. Zinc coat the upper 15 inches of the bolts and the nuts in accordance with ASTM A153/A153M. Provide anchor bolts and associated nuts, washers, and hardware meeting the requirements of subsection 908.14. Install anchor bolts as specified in section 810.

M. **Fused Safety Switch.** Provide the fused safety switch as shown on the plans.

918.11. Wood Poles

Provide western red cedar, red pine, or southern pine poles meeting the requirements of ASC O5 and ANSI O5.1.

Incise the circumferential surface area of poles beginning from at least 24 inches below the ground line and extending to at least 12 inches above the ground line. Machine shave poles full length above the incised area.

Treat poles full length with pentachlorophenol-petroleum preservative solution in accordance with AWPA T1-20 and AWPA P35-16. Provide a solution containing at least 5% of pentachlorophenol by weight.

A. **Guys and Guy Anchors.** Provide extra-high-strength-grade seven-strand guy wire. Provide heavy, two-bladed, malleable iron expansion-type guy anchors. Provide galvanized ¾-inch by 8-foot thimble eye type guy anchor rods. Provide anchor guys with metal or plastic guards.

B. **Miscellaneous Hardware.** Provide the hot-dip galvanized miscellaneous pole line hardware that is a standard product of electrical materials manufacturers.

Section 919. Permanent Traffic Sign and Support Materials

919.01. General Requirements

Permanent traffic signs and sign support material must meet the requirements of the *MDOT Sign Support Standard Plans* and this section.

919.02. Traffic Signs

The Department classifies signs by type of sign panel material and type of sign face, as follows:

Table 919-1:
Sign Panel and Face Types

		Sign Panel
Type	**Material**	**Size Limits**
I	Aluminum extruded sections	Height >48 inches or width >120 inches
II	Plywood	Height = 48 inches and width = 24 inches Minimum height ≥36 inches and width ≥36 inches Maximum height ≤48 inches and width ≤120 inches
III	0.080 inch aluminum sheet[(a)]	36 by 36 inches
IV	0.040 inch aluminum sheet[(a)]	Overlay
V	0.125 inch aluminum sheet[(a)]	48 by 48 inches and as shown in MDOT's SIGN-100 series
		Sign Face
Type	**Background**	**Legend and Border**
A	Reflectorized	Reflectorized
B	Reflectorized	Non-reflectorized
C	Non-reflectorized	Reflectorized

(a) Round the corners and remove burrs at the corners and mounting holes.

A. Sign Panel Material and Fabrication

1. **Aluminum Extruded Sections.** Provide aluminum extruded sections in a variety of widths with plain butt-type edges for connecting to adjoining horizontal sections. Sections must be one piece with no vertical splices and have a cross-sectional shape meeting the minimum requirements specified in Table 919-2. Sections must have at least a 0.125-inch nominal thickness. Exterior corners must have a radius of at least 0.040 inch.

   Sign panel sections must be extruded aluminum alloy 6063-T6 meeting the requirements of ASTM B221. Panel sections, after

fabrication, must be flat to within 0.031 inch or less per foot of length and to within 0.004 inch or less per inch of width.

Table 919-2:
Cross-Sectional Requirements for Aluminum Extruded Sign Sections for Type I Sign Panels

Length of Sign Support Type	Moment of Inertia	Section Modulus	Elements of Cross Section			
			No Free Ends		One Free End	
			b/t	≥I/y	b/t	≥I/y
≤30 feet on columns	≥0.94 W	≥0.55 W	8–50	56.0C	5–28	32.0A
≤20 feet on cantilevers ≤30 feet on trusses			>50	3.4D	>28	11.6B

Notes:
b = compression width of stiffener elements in inches
t = thickness of the stiffener element in inches
I = moment of inertia of the sign section in inches
y = distance from the neutral axis to the centroid of the compression width of the element
W = width of the sign section in feet
A = W/(63-b/t)
B = 1.0 × 10−4 W(b/t)²
C = W/(111-b/t).
D = 1.0 × 10−4 W(b/t)²

Degrease aluminum extruded sign panel sections in accordance with the sheeting manufacturer's recommendations. After degreasing, surface treating, and rinsing, maintain sign panels free of grease, oil, or other contaminants.

Connect the sections horizontally with ⅜-inch diameter stainless steel bolts, spaced as shown on the *MDOT Sign Support Standard Plans*. Section connections or sign-to-post connections must have no fasteners that project through the sign panel face.

Position the plank second from the bottom of the sign.

Position the 6-inch panel between two 12-inch panel sections. Do not use 6-inch panels for the signs top or bottom.

Before transporting sign panels, ensure that the support angles and wide flanged shapes are shop connected and remain on the sign.

2. **Plywood.** Plywood sign panels must be ⅝-inch thick and have a black or natural color overlay on both sides. Panels must meet the requirements of the U.S. Product Standard PS1-09 for Group 1 wood species, Grade B-B veneer, exterior type, high-density overlaid plywood. Inner plies must meet the requirements of Section 5.8.1, "Crossband Gaps and Center Gaps," of the U.S. Product Standard PS1-09. Inner plies must have no continuous core gaps, tunnels,

holes, or through openings that travel longitudinally or transversely through the plies, as measured from the panel edge. Crossband gaps or center gaps allowed by the U.S. Product Standard PS1-09 must be filled with a synthetic filler repair in accordance with Section 5.3, “Synthetic Repairs,” of the U.S. Product Standard PS1-09.

Do not make vertical splices in plywood signs. The Engineer will allow horizontal splices only for exit gore signs. Do not splice plywood sign panels unless otherwise shown on the sign details. Do not make horizontal splices through legends or symbols.

Prepare the plywood surface for sheeting application by lightly abrading the surface with a product recommended by the sheeting supplier. Do not power sand. Wipe the surface with a solvent and allow to dry in accordance with the sheeting manufacturer’s recommendations. Smooth and seal edges with one coat of exterior oil base paint.

After preparing the plywood surface, ensure that no grease, oil, or other contaminants come into contact with the surface.

3. **Aluminum Sheet.** Provide aluminum sheet for Type III, Type IV, and Type V sign panels meeting the requirements of ASTM B209 for aluminum alloy 6061-T6, 5052-H38, or 5154-H38.

   Aluminum sheet for Type III sign panels must be fabricated from nominal 0.080-inch-thick aluminum sheet with mill tolerance meeting the requirements of ASTM B209. Aluminum sheet for Type IV overlay sign panels must be fabricated from at least nominal 0.040-inch-thick aluminum sheet at least 0.037 inch thick.

   Degrease the aluminum sheet in accordance with the sheeting manufacturer’s recommendations. After degreasing, surface treating, and rinsing, maintain sign panels free of grease, oil, and other contaminants.

B. **Sign Face and Legend Material**

1. **Reflective Sheeting Material.** Select reflective sheeting for permanent signs from the Qualified Products List.

   Provide the Engineer with written certification that reflective sheeting meets the following requirements:

   a. Sheeting material on each sign is a Qualified Product obtained from the same sheeting manufacturer;

   b. Signs are manufactured in strict compliance with the sheeting manufacturer’s requirements; and

c. Each 145-foot-long roll of reflective sheeting contains no splices.

2. **Sheeting Application.** Fabricate and apply legends in accordance with the *Michigan Standard Highway Signs Manual* or as shown on the plans.

3. **Direct Applied Reflective Legend.** Cut legends with a smooth, regular outline, free of ragged or torn edges, and with interior corners cut to $^{3}/_{16}$-inch ± $^{1}/_{16}$-inch radius.

   Apply legends in accordance with the reflective sheeting manufacturer's recommendations.

   For Type I aluminum extruded sign sections, cut the legend components along each metal sign section joint after applying the legend.

4. **Non-Reflective Legend, Borders, and Arrows.** Provide non-reflective black material for legend, borders, and arrows and apply using ink, silkscreen method, or non-reflective sheeting. Provide material and apply non-reflective legends, borders, and arrows in accordance with the manufacturer's specifications.

5. **Reflective Panels.** Cut reflective sheeting strips at least 2 inches wide.

   Provide sheeting on reflective panel for permanent sign supports matching the material type and background color of the sheeting off the sign mounted on the post, except for YIELD and DO NOT ENTER signs where the reflective panel will be red.

   Attach the reflective strip to PVC or 0.080-inch-thick aluminum substrate. If aluminum is used on a u-channel post, a backing plate is required.

   Attach the reflective panel with stainless steel fasteners.

C. **Sign Hardware.** Steel shapes, bars, and plates must meet the requirements of ASTM A36/A36M or Department-approved equal and be hot-dip galvanized in accordance with ASTM A123/A123M.

   Bolts, nuts, washers, U-bolts, and straps must be stainless steel alloy meeting the requirements of ASTM A320/A320M for Class 1, Grade B8. Provide self-locking, nylon insert-type nuts meeting the requirements of ASTM A320/A320M and ASTM A194/A194M for Grade 8F. If using U-bolts formed from straight bar stock, ensure that the U-bolts are formed by cold working.

   Aluminum alloy shapes and plates must meet ASTM B308/B308M for aluminum alloy 6061-T6.

Cast post clips must conform to ASTM B108/B108, for aluminum alloy 356.0-T6.

Table 919-3:
Retroreflective Sign Sheeting Material Guidelines

Sign Category	Type	Material Type	Color
Yellow warning	W-series (non-school related), E13-1, E13-2, E11-1, OM-1, OM-2, OM-3	ASTM Type XI	Fluorescent yellow
School	S1-1, S4-3, S4-5, S4-5a, school portion of S5-1, W16-7p, W16-9p, W16-2, W16-2a	ASTM Type XI	Fluorescent yellow or green
Freeway guide	White legends, borders, and arrows	ASTM Type XI	White
	Background including M8 series signs	ASTM Type IV	Green, brown, or blue
Non-freeway guide	All	ASTM Type IV	White on green, brown, or blue
Regulatory	Stop, yield, parking, black-on-white signs	ASTM Type IV	—
Route markers	—	ASTM Type XI	—

919.03. Delineators

Fabricate reflectors for delineators from Type III aluminum substrate and reflective sheeting material for rigid post applications or solely from reflective sheeting material for flexible post applications as shown on the MDOT Standard Plan R-127 series. Provide the Engineer with a copy of the manufacturer's certification that reflectors and posts meet the requirements of this subsection.

A. **Aluminum Reflectors.** Reflectors for mounting on rigid post must consist of Type XI retroreflective sign sheeting applied to Type III aluminum substrate.

Fabricate the specified delineator reflector size(s) from the Type III aluminum substrate and round all exterior corners to a ¾-inch radius. Remove any burrs that form while rounding the corners. Apply the sign sheeting to cover the entire face of the aluminum substrate and ensure that the sheeting is free of seams, wrinkles, bubbles, tears, gaps, and other defects after the corners are rounded and before the mounting holes are cut. The mounting holes must be 3/8 inch in diameter and located per the MDOT Standard Plan R-127 series. Two mounting holes must be cut in each delineator reflector. Remove burrs from the mounting holes.

B. **Reflective Sheeting Reflectors.** Provide reflective sheeting for mounting on flexible posts meeting the material, color, and resistance to weathering requirements of ASTM D4956 for Type XI flexible retroreflective sheeting.

Apply reflective sheeting in accordance with the manufacturer's specifications.

C. **Mounting Hardware.** Mounting hardware for aluminum reflectors must consist of a drive rivet or bolt system.

Drive rivets may be aluminum or stainless steel. For aluminum drive rivets, both the pin and the collar must meet the requirements of ASTM B308/B308M for aluminum alloy 6061.

Bolts must be stainless steel and accompanied by a locknut to produce a vandal-resistant attachment. A nylon washer is also required to be placed between the bolt head and the face of the reflector to protect the sign sheeting.

Ensure that either system has a large enough diameter that it will not be subject to pulling through the holes in the delineator reflectors or posts.

Alternative fastening systems may be approved by the Engineer provided they form a vandal-resistant attachment.

D. **Posts.** Provide rigid steel or flexible delineator posts. Steel delineator posts must have a nominal weight of 1.12 pounds per foot and meet the requirements of subsection 919.04 for steel posts. Select flexible delineator posts from the Qualified Products List.

919.04. Steel Post Sign Supports and Square Tubular Steel Sign Supports

Provide steel post sign supports and square tubular steel sign supports, including sign posts, anchor sleeves, and anchor posts, meeting the requirements of ASTM A702.

A. **Steel Post Sign Supports.** Posts must be straight with a smooth, uniform finish and free of cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, or other defects that affect the strength, durability, or appearance of the posts. Provide cross-section, bolt-hole diameter, and spacing meeting the requirements shown on the *MDOT Traffic and Safety Sign Support Standard Plans*. Align the centers of the holes to coincide with the centerline of the posts. The punched bolt holes must provide a smooth, even sign post face. Holes and cutoff ends must be free of burrs.

After fabrication and hole punching, hot-dip galvanize steel posts in accordance with subsection 907.03.D.

Provide punched and coated posts weighing at least 95% of the nominal weight shown on the plans.

B. **Square Tubular Steel Sign Supports.** Provide square tubular steel sign supports meeting the chemical, mechanical, and geometric properties of material used in the crash tests referenced in AASHTO's *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.

Sign posts, anchor sleeves, anchor posts, and connection hardware must be of the size and type shown on the *MDOT Sign Support Standard Plans*.

Provide straight sign posts, anchor sleeves, and anchor posts with a smooth uniform finish and free from cracks and flaws or other defects that affect their strength or durability. Provide cut square ends free from burrs.

Accurately space bolt holes of the specified diameter on all four sides of the sign post, anchor sleeve, and anchor post. Line up holes exactly opposite each other on opposing sides of the post in order to accommodate a bolt placed through two opposite sides. Align the center of the holes with the centerline of the sign post, anchor sleeve, and anchor post.

Punch the bolt holes so the face of the sign post, anchor sleeve, and anchor post will have a smooth even surface.

Hot-dip galvanize the sign post, anchor sleeve, and anchor post after fabrication and hole punching in accordance with ASTM A123/A123M for Grade 65.

919.05. Sawed Wood Posts for Highway Signs

Provide sawed wood posts for highway signs meeting the requirements of section 912 and Sign Support Standard SIGN-210.

919.06. Steel Column Breakaway Sign Supports

Provide structural steel for column sign supports and bolts, nuts, and washers for the structural steel joints meeting the requirements of Sign Support Standard SIGN-220.

Provide steel shims meeting the requirements of ASTM A36/A36M and galvanize in accordance with ASTM A123/A123M.

919.07. Cantilever Sign Supports

A. **Upright Column.** Provide pipe for the upright column of Type E cantilevers meeting the requirements of ASTM A53/A53M for Grade B,

Type E or Type S, steel pipe or meeting the requirements of API-5L for Grade X42 to X52. Provide pipe for the upright column of Type J cantilevers meeting the requirements of ASTM A53/A53M for Grade B, Type E or Type S, steel pipe or meeting the requirements of API-5L Grade X42.

B. **Horizontal Arms.** Provide pipe for the horizontal arms of Type E cantilevers meeting the requirements of ASTM A53/A53M for Grade B, Type E or Type S, steel pipe or meeting the requirements of API-5L for Grade X42 to X52. Provide pipe for the horizontal arms of Type J cantilevers meeting the requirements of ASTM A500/A500M, Grade B or ASTM A519/A519M, Grade 4140 annealed.

C. **Gussets, Flanges, and Base Plates.** Provide plate material for gussets, flanges, and base plates meeting the requirements of ASTM A36/A36M. Plates must be free of sharp edges and irregularities.

D. **Angles.** Provide angles meeting the requirements of ASTM A709/A709M, Grade 36, or ASTM A36/A36M.

E. **Pole and End Caps.** Provide pole and end caps meeting the requirements of ASTM A36/A36M.

F. **Arm Connection Bolts.** Provide high-strength bolts, nuts, washers, and lock washers for arm connections meeting the requirements of subsection 906.07.

G. **Anchor Bolts.** Provide anchor bolts, nuts, and washers meeting the requirements of subsection 908.14.

H. **Dimension Tolerances.** Ensure that cross sections, flatness, length, straightness, thickness, and camber of material before and after fabrication meet the tolerance requirements of ASTM A6/A6M and AWS D1.1/D1.1M.

I. **Galvanizing.** Galvanize cantilever sign supports galvanized in accordance with ASTM A123/A123M. Blast clean all components to remove excess mill scale and welding slag before galvanizing.

Provide safeguards meeting the requirements of ASTM A384/A384M and ASTM A385/A385M to obtain high-quality galvanized coatings and to minimize distortion and warpage during galvanizing.

Interconnect sections of fabricated pipe work or tube assemblies with open tee or miter joints and provide each enclosed section with a vent hole at each end to provide drainage for the molten zinc and to prevent a hazard to personnel engaged in the galvanizing process.

919.08. Truss Sign Supports

Before applying dead loads, trusses must be cambered so the ordinate is within the allowable tolerances at the center of the assembled truss for the span length and type shown on the plans. Ensure that bearing surfaces fully contact each other in the relaxed position before tightening the flange bolts. The fabricator will determine the method of cambering the structure, with the Engineer's approval, to ensure that the method does not induce stress into the truss.

A. **Upright Column.** Provide hollow structural tubing for upright columns of Type C and D trusses meeting the requirements of ASTM A500/A500M for Grade B or API-5L for Grade X42 to X52. Provide pipe for upright columns of Type E trusses meeting the requirements of ASTM A53/A53M for Grade B, Type E or Type S, steel pipe or the requirements of API-5L Grade X42.

B. **Horizontal Truss Boxes.** Provide pipe for the horizontal truss boxes of Type C and D trusses meeting the requirements of ASTM A53/A53M for Grade B, Type E or Type S, steel pipe or meeting the requirements of API-5L for Grade X42 to X52. Provide pipe for the horizontal arms of Type E trusses meeting the requirements of ASTM A500/A500M, Grade B, or ASTM A519/A519M, Grade 4140 annealed.

C. **Gussets, Flanges, and Base Plates.** Provide plate material for gussets, flanges, and base plates meeting the requirements of ASTM A36/A36M. Plates must be free of sharp edges and irregularities.

D. **Angles.** Provide angles meeting the requirements of ASTM A709/A709M, Grade 36, or ASTM A36/A36M.

E. **Pole and End Caps.** Provide pole and end caps meeting the requirements of ASTM A36/A36M.

F. **Truss Box Connection Bolts.** Provide high-strength bolts, nuts, washers, and lock washers for truss box connections meeting the requirements of subsection 906.07.

G. **Anchor Bolts.** Provide anchor bolts, nuts, and washers meeting the requirements of subsection 908.14.

H. **U-Bolts.** Provide U-bolts and washers meeting the requirements of ASTM A320/A320M, Grade B8, Class 1, stainless steel. Provide self-locking nylon insert-type nuts meeting the requirements of ASTM A320/A320M for Grade B8F.

I. **Dimension Tolerances.** Ensure that cross sections, flatness, length, straightness, thickness, and camber of material, before and after

fabrication, meet the tolerance requirements of ASTM A6/A6M and AWS D1.1/D1.1M.

J. **Galvanizing.** Provide galvanized truss sign supports in accordance with ASTM A123/A123M. Blast clean all components to remove excess mill scale and welding slag before galvanizing.

Provide safeguards meeting the requirements of ASTM A384/A384M and ASTM A385/A385M to obtain high-quality galvanized coatings and to minimize distortion and warpage during galvanizing.

Interconnect sections of fabricated pipe work or tube assemblies with open tee or miter joints and provide each enclosed section with a vent hole at each end to provide drainage for the molten zinc and to prevent a hazard to personnel engaged in the galvanizing process.

919.09. Overhead Lane Assignment Structures

Provide overhead lane assignment structures meeting the requirements of Sign Support Standard SIGN-760 and traffic signal typical plans.

919.10. Casings for Cantilever Drilled Piles

Provide casings for cantilever drilled piles meeting the requirements of ASTM A252/A252M for Grade 2 steel. Casings must be smooth, watertight, and capable of withstanding handling stresses and external subsurface pressures. Provide casing with an OD at least equal to the required shaft size.

Section 920. Permanent Pavement Marking Materials

920.01. Marking Materials

Select pavement marking materials from the Qualified Products List.

When selecting preformed thermoplastic products, ensure that preformed thermoplastic materials have a thickness of 90 mils for surface applications and a thickness of 125 mils for recessed applications.

For black liquid shadow markings and blue markings used in parking areas, choose a specified binder material and color from the Qualified Products List or select a white specified binder material from the Qualified Products List and tint the product to the appropriate color.

Use liquid applied pavement marking materials manufactured in the previous 12 months or within the shelf life directed by the manufacturer, whichever is less. Use solid applied materials within the shelf life directed by the manufacturer. Provide certification that liquid and solid applied pavement marking materials have been stored per the manufacturer's requirements. Materials not in compliance will be rejected and removed at the Contractor's expense.

A. **General Packaging and Labeling.** Material containers or packages must be marked on the tops and sides using a durable, weather-resistant marking. Include the following information:

   1. Manufacturer's name and address;
   2. Description of the material;
   3. Product identification number;
   4. Lot or batch number;
   5. Date of manufacture;
   6. Volume; and
   7. Weight.

B. **Packaging and Labeling for Cold Plastic and Thermoplastic Markings**

   1. **Cold Plastic.** Containers or packages of cold plastic material and the core of each roll must be marked with the information specified in subsection 920.01.A.
   2. **Thermoplastic.** In addition to the requirements of subsection 920.01.A, thermoplastic material must be packaged in non-stick

containers and labeled with “heat to manufacturer-recommended temperature range.”

920.02. Glass Beads and Wet Reflective Optics

A. **Packaging and Labeling.** Package glass beads and wet reflective optics in moisture-resistant bags and label with the following information:

1. Manufacturer’s name and address;
2. Shipping point;
3. Trademark or name;
4. The wording “Glass Beads” or “Optics”;
5. Specification number;
6. Weight;
7. Lot or batch number; and
8. Date of manufacture.

Drop-on AASHTO M247 Type I beads are herein referred to as standard glass beads. Large glass beads must meet federal specification TTB-1325 for a Type 4 glass bead. All glass beads and wet reflective optics to be used on Federal-aid projects must contain no more than 200 parts per million of arsenic or lead, as determined in accordance with Environmental Protection Agency testing methods 3052, 6010B, or 6010C.

B. **General Requirements for Standard Glass Beads.** Standard glass beads must meet the physical characteristics and gradation requirements specified in Table 920-1 unless otherwise specified in subsection 920.02.D for specific applications.

Table 920-1: General Requirements for Standard Glass Bead: Physical Characteristics (MTM 711)

Characteristic	Requirement
General appearance	Transparent, clean, smooth, free from milkiness, pits, or excessive air bubbles
Shape	Spherical with ≥75% true spheres
Color	Colorless, very light gray, very light gray tinge, or bright white
Index of refraction	≥1.50
Alkalinity	≤2.0

Table 920-2: Gradation Requirements (MTM 711)

Sieve Size (No.)	Total % Passing
20	100
30	75–95
50	15–35
100	0–5

C. **General Requirements for Wet Reflective Optics.** Select wet reflective optics from the Qualified Products List or a Department-approved alternative that meets or exceeds the retroreflectivity requirements specified in Table 920-2.

Prior to application, submit certification from the wet reflective optics manufacturer that when applied according to the manufacturer's application recommendations, the wet reflective optics meet the requirements in Table 920-2.

Table 920-3:
General Wet Reflective Optic Requirements: Average Initial Retroreflectivity at 30-meter Geometry in mcd/lux/m^2

	Color	
Test Method	**White**	**Yellow**
Dry (ASTM E1710)	700	500
Wet recovery (ASTM E2177)	250	200
Wet continuous (ASTM E2832)	100	75

D. **Standard Glass Bead and Wet Reflective Optic Requirements for Specific Applications**

1. For recessed longitudinal markings, use a double-drop system of large and standard glass beads, a double-drop system of wet reflective optics and standard glass beads, or an Engineer-approved alternative. Ensure that large glass beads meet federal specification TTB-1325 for a Type 4 glass bead.

2. **Waterborne and Low-Temperature Waterborne.** Standard and large glass beads for use with waterborne marking material and low-temperature waterborne marking material require a moisture-resistant coating and a silane coating. The type, gradation, and application rates for wet reflective optics used with waterborne and low-temperature waterborne marking materials must meet the waterborne manufacturer's recommendations.

3. **Regular Dry.** Standard and large glass beads for use with regular dry marking material may have a moisture-resistant coating, a silane

coating, or both. The type, gradation, and application rates for wet reflective optics used with regular dry marking materials must meet the regular dry manufacturer's recommendations.

4. **Thermoplastic.** Standard and large glass beads for thermoplastic marking material must have a moisture-resistant coating. The type, gradation, and application rates for wet reflective optics used with thermoplastic marking materials must meet the thermoplastic manufacturer's recommendations.

5. **Sprayable Thermoplastic.** The type, gradation, and application rates for all standard and large glass beads and wet reflective optics used with sprayable thermoplastic marking material must meet the sprayable thermoplastic manufacturer's recommendation.

6. **Polyurea.** The type, gradation, and application rates for all standard and large glass beads and wet reflective optics used with polyurea marking material must meet the polyurea manufacturer's recommendation.

7. **Modified Epoxy.** The type, gradation, and application rates for all standard and large glass beads and wet reflective optics used with modified epoxy marking material must meet the modified epoxy manufacturer's recommendation.

Section 921. Permanent Traffic Signal Materials

921.01. Sampling and Testing

A. **General.** The Department may select permanent traffic signal materials covered by this section at random from shipments and test in accordance with Department methods. If requested by the Department, complete one installation for preliminary testing. If the preliminary sample does not meet the requirements of this section, the Department will notify the Contractor, in writing, of deficiencies so the Contractor may make the necessary changes or corrections in materials or installation methods. The Department may retest traffic signal materials after the Contractor makes the necessary changes or corrections.

B. **Loop Detectors.** The Department will randomly select one or more loop detectors from the shipment and perform testing as specified in subsection 921.01.A. If the tested loop detector meets the requirements of subsection 921.01.A, the Department will give the Contractor written notification to provide the remainder of the order, which will be subject to testing.

   If the tested loop detector does not meet the requirements of subsection 921.01.A, the Department will notify the Contractor, in writing, of deficiencies so the Contractor may make changes or corrections in materials or installation methods. All loop detectors will then be subject to testing. If the Contractor does not, or cannot make corrections, the Department will require the Contractor to provide materials from other sources in accordance with section 105.

C. **Warranty.** Provide materials with a manufacturer's guarantee or warranty, transferable to the Department, that the material is free of defects in materials and workmanship for a specified period from the date of installation. Provide the Engineer with the manufacturer's guarantee or warranty documents and a copy of the invoice showing date of shipment.

921.02. Messenger Wire and Span Wire

Use extra-high-strength Grade, 7-wire, Class A, zinc-coated steel meeting the requirements of ASTM A475.

A. Provide messenger wire with a nominal diameter of ¼ inch for supporting traffic signal cables. Self-supporting figure-8 type cable must incorporate a $^{1}/_{4}$-inch messenger wire.

B. Provide span wire with a nominal diameter of $^{5}/_{16}$ inch for supporting a traffic signal, case sign, and cable. Messenger wire is incidental to the traffic signal installation.

921.03. Vehicular Traffic Signals and Mounting Assemblies

Unless otherwise required, provide traffic signals meeting the requirements of the Institute of Traffic Engineers (ITE) *A Standard for Adjustable Face Vehicle Traffic Control Signal Heads, Vehicle Traffic Control Signal Heads* (referred to herein as ITE VTCSH), ITE *Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement,* dated June 27, 2005 (referred to herein as the ITE *LED Circular Signal Supplement)*, and ITE *Vehicle Traffic Control Signal Heads: LED Vehicle Arrow Traffic Signal Supplement,* dated April 3, 2006 (referred to herein as the ITE *LED Vehicle Arrow Traffic Signal Supplement*).

Provide adjustable face-type traffic signals with 12-inch-diameter lenses. Provide signal sections of the same make and type to ensure that they are interchangeable. Signal faces include LED traffic signal modules for ball lenses or arrow lenses or both, socket assembly gaskets, reflector and door assembly, housing, visors, optical units, wiring, and mounting assembly. Provide LED vehicular traffic signals compatible in new installations or as a retrofit unit capable of replacing the optical unit of existing vehicular traffic signal sections meeting all standards and requirements.

A. **Housing.** Provide polycarbonate plastic housing. Provide each signal body with a 2-inch-diameter hole in the top and bottom to receive 1½-inch-diameter supporting pipe. Provide AISI Series 300 stainless steel fasteners if at least partially exposed on the exterior of the assembled housing. Provide AISI Series 300 stainless steel screws, bolts, nuts, and hinge pins for the interior of the housing. Provide other hardware used on the interior in AISI Series 300 stainless steel, brass, or aluminum. Do not use plastic fasteners to secure the door.

B. **Visor.** Provide each signal face with a detachable tunnel design visor for each signal lens. Provide a visor from 9 to 12 inches long for 12-inch lenses. Provide a visor that encloses at least 290 degrees of the lens circumference and tilts downward from 1 to 10 degrees. Provide a one-piece solid polycarbonate circular visor at least 0.078 inch thick. Attach the visor to the signal section.

C. **LED Module and Signals.** LED signals and modules include circular and arrow modules unless otherwise specified.

   Provide new Department-approved LED signals of the latest model currently in production. Equipment that is no longer manufactured is not acceptable even if it meets the requirements of this subsection. Install all LED signals produced by the same manufacturer at one location.

   1. **Physical and Mechanical Requirements**. Provide self-contained, sealed LED module units consisting of a lens, color-coded leads with

pre-insulated spade lugs, a LED assembly, a power supply, and a one-piece neoprene gasket. Use material for the lens and module construction that meets ASTM requirements. Provide enclosures to contain the power supply or electronic components for the signal module made of UL94 flame-retardant material. If retrofitting into existing traffic signal housing, provide the LED module with a new signal door and visor assembly.

The LED module and the internal LED and electronic components must withstand mechanical shock and vibration in accordance with MIL STD 883, Test Method 2007. Verify that the LED vehicle signal manufacturer is ISO 9001 certified.

Provide an LED signal module that protects against dust and moisture intrusion in accordance with MIL STD 810F, Procedure I, “Rain and Blowing Rain,” testing. Conduct the test on stand-alone units with no protective housing.

Provide an LED signal module lens made from UV-stabilized polycarbonate. Use lenses that are color tinted red, yellow, and green to match the color of the LEDs. Provide lenses that do not require special tools for replacement. Provide a hard-coated lens or a lens that otherwise complies with the material exposure and weathering effects requirements of SAE J576. Attach the lens to the signal body and apply a waterproof silicone seal.

Provide lenses for vehicle signals with smooth external lens surfaces and no raised features to minimize the collection of dirt, diesel smoke, and other particulate contaminates and to facilitate periodic cleaning.

Ensure that each signal module identifies the manufacturer’s name, model number, serial number, related voltage, and power consumption on the outside of the unit. Attach the identification tag using polyester or vinyl self-adhesive labels and make visible without disassembling the signal module. Do not use paper labels.

For each LED signal module, provide a prominent and permanent vertical indicator for the orientation of the module inside the traffic signal housing.

Provide LED modules that incorporate a dual-lens approach using a single inner collimating lens and a single outer spreading lens. Provide an inner Fresnel lens that collimates the light emitted by the LED and spans the full diameter of the interior of the signal. Provide an outer lens that distributes the light rays through raised optical detail on the inner surface to meet the intensity and distribution standards specified in this section.

Provide LED modules that incorporate two separate printed circuit boards: one for the LED light source and one for the power supply. Provide LED modules consisting of high flux LEDs mounted on a metal core circuit board using thermal epoxy and LED electrical contacts soldered to the circuit board. Place a single layer of thermal transfer material between the metal core printed circuit board and the module heat sink to ensure optimum heat transfer away from the LED P-N junctions.

Provide a lens assembly that disperses the light to prevent visibility of individual LEDs from vehicles.

Provide watertight LED signals when installed in traffic signal housing. Provide the same mounting hardware for LED signal modules as used to secure incandescent lens and gasket assemblies. Ensure that installation requires only a screwdriver or standard installation tool. Provide an LED signal module assembly that weighs less than 5 pounds.

Mount and solder the LED arrow module to a printed circuit board. Provide an LED arrow module that uses a single outer lens that spreads and diffuses light from the LEDs. Incorporate a black arrow mask behind the outer lens to enhance the definition of the arrow icon. Provide an outer lens with raised optical detail on the inner surface to distribute the light rays to meet the intensity and distribution standards required by this subsection.

2. **Electrical Requirements.** Provide LED signal modules that operate from a 60-hertz line frequency and over a voltage range from 80 to 135 volts. A change of luminous intensity no greater than 10% over the voltage range is allowed.

   Provide an LED signal module capable of operating over a temperature range from −40 to 165°F.

   Provide each LED signal module with two color-coded, No. 18 gauge minimum, anti-capillary 39-inch-long, 600-volt, jacketed wires conforming to the requirements of the NEC, rated for service at 221°F. Provide the LED module wire leads with insulated spade lug terminals for connecting to existing traffic signal terminal blocks.

   Provide LED signal modules with voltage surge protection to withstand high repetition noise transients and low-repetition, high-energy transients in accordance with NEMA Standard TS-2.

   Provide LED circuitry that prevents flicker at less than 100 hertz over the voltage range from 80 to 135 volts in accordance with the ITE VTCSH.

Provide LED signals and associated on-board circuitry meeting Federal Communications Commission (FCC) regulations in 47 CFR Part 15, Subpart B, concerning the emission of electronic noise by Class A digital devices.

Ensure a power factor of at least 90%, at nominal rated voltage, at 77°F. Ensure a total harmonic distortion of less than 20% at rated voltage, at 77°F.

Ensure that the failure of a single LED will not cause a loss of light from other LEDs. Provide LED ball lamps that do not lose light output from the complete module assembly as a result of the failure of a single LED.

Provide an LED module that will detect catastrophic loss of the LED load. Provide a module that, upon sensing the loss of the LED load, presents a resistance of at least 250 kiloohms across the input power leads within 300 milliseconds. Catastrophic failure of an LED light source is if it fails to show visible illumination when energized in accordance Section 5.2.1 of the ITE *LED Circular Signal Supplement* after 75 milliseconds or Section 5.7 of the ITE *LED Vehicle Arrow Traffic Signal Supplement*.

Provide an LED signal module that is operationally compatible with current controller assemblies including solid state load switches, flashers, and conflict monitors.

Wire the LED modules with at least No. 18 AWG, color-coded thermoplastic insulated wire.

Provide a six-point terminal block with stainless steel or chrome-plated brass screw terminals for spade lugs of brass, stainless steel, or other non-corrosive material and for connecting wires from the LED module and the cable from the signal controller. Mount the terminal block in the center section of the signal face and provide at least 1-inch lateral clearance from the housing. Install the terminal block with stainless steel screws.

Mount and locate the terminal block and other appurtenances in the housing to minimize the danger of electrical shock during maintenance activities.

3. **Power Consumption and Operational Range**. Provide LED traffic signal modules that meet the minimum intensity requirements while operating from temperatures of −40 to 165°F for 5 years.

Provide high flux LED capable of being driven continuously at a current of at least 350 milli-amperes with a power dissipation rating of at least 1 watt.

Provide LEDs that do not illuminate for input voltages below 35 volts but illuminate for input voltages greater than 45 volts and are regulated above 80 volts.

Provide LED modules for traffic signals with the following maximum power consumption:

a. 8-inch and 12-inch red ball traffic signal modules with a maximum power consumption no greater than 6 watts and 9 watts respectively, at 120 VAC, at 77°F;

b. 8-inch and 12-inch yellow ball traffic signal modules with a maximum power consumption no greater than 13 watts and 19 watts, respectively, at 120 VAC, at 77°F;

c. 8-inch and 12-inch green ball traffic signal modules with a maximum power consumption no greater than 6 watts and 12 watts, respectively, at 120 VAC, at 77°F;

d. 12-inch red arrows with a maximum power consumption no greater than 7 watts at 120 VAC, at 77°F;

e. 12-inch yellow arrows with a maximum power consumption no greater than 9 watts at 120 VAC, at 77°F; and

f. 12-inch green arrows with a maximum power consumption no greater than 7 watts at 120 VAC, at 77°F.

Ensure that each LED module reaches 90% full illumination within 75 milliseconds of applying the nominal operating voltage. Ensure that modules do not show visible illumination after 75 milliseconds of removing the nominal operating voltage.

Provide red LEDs that use aluminum indium gallium phosphide technology exclusively, either absorbing substrate or transparent substrate, and that do not exhibit degradation greater than 30% of the initial light intensity following accelerated life testing (operating at 185°F and 85% humidity for 1000 hours). Do not use aluminum gallium absorbing substrate technology.

Provide green LEDs that use indium gallium nitride technology. Provide green LED traffic signal modules that do not illuminate if the applied voltage is less than 35 VAC. Provide green LEDs that illuminate, unregulated, if the applied voltage is from 45 to 80 VAC.

Provide green LEDs that illuminate in accordance with the ITE VTCSH, Part II, if applied voltage is from 80 to 135 VAC.

Provide yellow LEDs that use aluminum indium gallium phosphide technology, absorbing substrate or transparent substrate. Provide yellow LED traffic signal modules that do not illuminate if the applied voltage is less than 35 VAC. Provide yellow LEDs that illuminate, unregulated, if the applied voltage is from 45 to 80 VAC. Provide yellow LEDs that illuminate in accordance with the ITE VTCSH if applied voltage is from 80 to 135 VAC.

Provide LED modules operationally compatible with NEMA TS-1 and NEMA TS-2 conflict monitoring parameters.

4. **Photometric Requirements**. Refer to Section 4, Table 1, of the ITE *LED Circular Signal Supplement* and the *LED Vehicle Arrow Traffic Signal Supplement* for the minimum initial luminous intensity values for the LED traffic signal module.

   Ensure that the actual luminous intensity for a module does not exceed three times the required peak value of the minimum maintained luminous intensity for the signal size and color if operated within the temperature range specified in Section 3.3.2 of the ITE *LED Circular Signal Supplement* and the *LED Vehicle Arrow Traffic Signal Supplement*.

   Ensure that the uniformity of the signal output across the module lens does not exceed a ratio of 10:1 from the maximum to minimum luminance values.

   Provide LED modules with surfaces that appear uniform in illumination. Eliminate the visibility of individual LEDs to the motorist.

   Ensure that the measured chromaticity coordinates of LED traffic signal modules conform to the color regions based on the 1931 CIE chromaticity diagram listed in the ITE *LED Circular Signal Supplement*.

   Ensure that the dominant wavelength for individual color measurements of portions of the emitting surface of a module are within 3 nanometers of the dominant wavelength for the average color measurement of the entire emitting surface.

   Provide LED modules operationally compatible with NEMA TS-1 and NEMA TS-2 conflict monitoring parameters.

   Provide LED traffic signal modules that meet the minimum luminous intensity values listed in Table 921-1 for circular modules, or Table 921-2 for arrow modules, for 60 months.

Table 921-1:
Minimum Maintained Luminous Intensity Values — VTCSH LED Circular Signal

Vertical Angle (°)	Horizontal Angle (°)	Luminous Intensity (candela)[a][b]					
		8 inch			12 inch		
		Red	Yellow	Green	Red	Yellow	Green
+12.5	2.5	17	41	22	37	91	48
	7.5	13	33	17	29	73	38
+7.5	2.5	31	78	41	69	173	90
	7.5	25	62	32	55	137	71
	12.5	28	45	24	40	100	52
+2.5	2.5	68	168	88	150	373	195
	7.5	56	139	73	124	309	162
	12.5	38	94	49	84	209	109
	17.5	21	53	28	47	118	62
	22.5	12	29	15	26	64	33
−2.5	2.5	162	402	211	358	892	466
	7.5	132	328	172	292	728	380
	12.5	91	226	118	201	501	261
	17.5	53	131	69	117	291	152
	22.5	28	70	37	62	155	81
	27.5	15	37	19	33	82	43
−7.5	2.5	127	316	166	281	701	366
	7.5	106	262	138	234	582	304
	12.5	71	176	92	157	391	204
	17.5	41	103	54	91	228	119
	22.5	21	53	28	47	118	62
	27.5	12	29	15	26	64	33
−12.5	2.5	50	123	65	110	273	143
	7.5	40	98	52	88	218	114
	12.5	28	70	37	62	155	81
	17.5	17	41	22	37	91	48
	22.5	8	21	11	18	4	24
	27.5	5	12	6	11	27	14
−17.5	2.5	23	57	30	51	127	67
	7.5	18	45	24	40	100	52
	12.5	13	33	17	29	73	38
	17.5	7	16	9	15	36	19
	22.5	3	8	4	7	18	10

Table 921-1 (cont.):
Minimum Maintained Luminous Intensity Values — VTCSH LED Circular Signal

Vertical Angle (°)	Horizontal Angle (°)	Luminous Intensity (candela)[a][b]					
		8 inch			12 inch		
		Red	Yellow	Green	Red	Yellow	Green
−22.5	2.5	17	41	22	37	91	48
	7.5	13	33	17	29	73	38
	12.5	10	25	13	22	55	29
	17.5	5	12	6	11	27	14
−27.5	2.5	12	29	15	26	64	33
	7.5	8	21	11	18	46	24

(a) Luminous intensity values for equivalent left and right horizontal angles are the same.

(b) Tabulated values of luminous intensity are rounded to the nearest whole value.

Table 921-2:
Minimum Maintained Luminous Intensity Values for the VTCSH LED Vehicle Arrow Traffic Signal

Vertical Angle (°)	Horizontal Angle (°)	Luminous Intensity (candela)[a][b]		
		12-inch arrow		
		Red	Yellow	Green
+12.5	2.5	6	15	8
	7.5	5	12	6
+7.5	2.5	11	28	14
	7.5	9	22	11
	12.5	6	16	8
+2.5	2.5	24	60	31
	7.5	20	49	26
	12.5	13	33	17
	17.5	8	19	10
	22.5	4	10	5
−2.5	2.5	57	143	75
	7.5	47	116	61
	12.5	32	80	42
	17.5	19	47	24
	22.5	10	25	13
	27.5	5	13	7

Table 921-2 (cont.):
Minimum Maintained Luminous Intensity Values for the VTCSH LED Vehicle Arrow Traffic Signal

Vertical Angle (°)	Horizontal Angle (°)	Luminous Intensity (candela)[a][b]		
		12-inch arrow		
		Red	Yellow	Green
−7.5	2.5	45	112	59
	7.5	37	93	49
	12.5	25	63	33
	17.5	15	36	19
	22.5	8	19	10
	27.5	4	10	5
−12.5	2.5	18	44	23
	7.5	14	35	18
	12.5	10	25	13
	17.5	6	15	8
	22.5	3	7	4
	27.5	2	4	2
−17.5	2.5	8	20	11
	7.5	6	16	8
	12.5	5	12	6
	17.5	2	6	3
	22.5	1	3	2
−22.5	2.5	6	15	8
	7.5	5	12	6
	12.5	4	9	5
	17.5	2	4	2
−27.5	2.5	4	10	5
	7.5	3	7	4

(a) Luminous intensity values for equivalent left and right horizontal angles are the same.

(b) Tabulated values of luminous intensity are rounded to the nearest whole value.

D. **Electrical Wiring.** Provide stranded wire electrical wiring meeting the requirements of ITE standards.

Electrically and mechanically secure the wiring by fastening to the lamp receptacle. Insulate exposed, current-carrying parts. Use pre-insulated fork-type terminals on the wires at the terminal block connection.

Do not use pressure-type terminal blocks.

E. **Mounting Assemblies.** Provide mounting assemblies that include the hardware for complete assembly of the signal.

1. **Pipe.** For mounting assemblies, use rigid conduit of 1½-inch standard steel pipe with straight threads. Do not use straight threads. Install plastic thread protectors for exposed pipe threads to protect the threads during shipping.

2. **Hub or Center Fitting.** Provide a hub of malleable iron with a nominal 3- by 3-inch opening to draw wires and make connections. Secure the cover for the opening with two ⅜- by ½-inch hexagon head, AISI 300 Series stainless steel screws. Close unused openings in the hub with ferrous or aluminum ornamental closures.

3. **Arms.** Provide pipe arms from the center hub to position the centers of the signal face housings on a radius of 8¾ inches ± ¼ inch from the hub for 8-inch signals and a radius of 10¾ inches ± ¼ inch from the hub for 12-inch signals.

4. **Fittings.** Use ferrous pipe crosses to make right angles in mounting frames. Close unused openings of the pipe crosses with ornamental closures. Do not use set screws in pipe crosses.

   Provide malleable iron fittings free of flash and voids.

5. **Assemblies.** Construct the signal stem of 1½-inch standard steel pipe and fittings. Install reinforcing plates in the top and bottom of all signals equipped with back plates. Do not use rivets.

6. **Finish.** Provide pipes and fittings with internal surfaces that are free of sharp edges and burrs.

7. **Cable Entrance Fitting.** Provide fittings of one-piece construction, made of malleable iron. Provide the wire outlet with a composition bushing with opening to accommodate a multi-conductor cable, 1 inch in diameter. Provide the threaded end of the fitting with a threaded nipple, two 1½-inch malleable iron locknuts, and a stainless steel cotter key.

8. **Span Wire Fitting.** Provide fittings of malleable iron to accommodate ¼- to ⅜-inch messenger wire with a 1⅝-inch diameter pin and $^{3}/_{32}$- by 1-inch stainless steel cotter key. Locate the pin $3^{7}/_{16}$ inches from where the span cable seats into the saddle part of the fitting. Provide a saddle part 9 inches long. Bottom-tethering span assemblies must have breakaway attachment points on both ends.

9. **Span and Cable Entrance Assembly.** Provide a span and cable entrance assembly that allows the signal assembly to swing in any direction and return to the vertical position without placing stress on the span wire.

10. **Signal Head Attachment.** Provide the top outlet of each signal bracket with a nipple and either a watertight metal gasket with retainer to restrict the flow of the gasket or one flat, stainless steel washer and one malleable iron hexagon nut, ½ inch thick.

    Provide a nipple to allow the use of the gasket or nut and washer.

F. **Paint and Color**

1. **Mounting Assemblies.** Clean and surface treat the surfaces of mounting assemblies in accordance with standard industry practice to ensure bonding of the paint to the metal. After preparation, paint surfaces with durable weather-resistant semi-gloss or gloss yellow enamel.

   Apply the enamel at an average dry film thickness of 1.5 mils without blisters, runs, or other defects. Determine the dry film thickness using Method A, Inductance Thickness Gauge, as specified in ASTM D1400. Ensure that the color matches the central color within the limits shown on the current Federal Highway Administration (FHWA) Highway Yellow Color Tolerance Chart, except do not use a color darker than the central color.

2. **Signal Faces.** Provide signal faces with the yellow color specified in subsection 921.03.F.1, permanently molded into the signal door, housing, and visors. Provide the inside of the visors with a finish coat of flat black paint that is compatible with polycarbonate plastic.

G. **Packing and Marking.** Pack each traffic signal separately to prevent damage to the signal and mounting assembly during transportation to the project. Legibly mark each carton with the signal and mounting assembly description and supplier's name.

H. **Quality Assurance (QA).** Provide LED modules that comply with the QA production testing, inspection, and design as specified in the ITE *LED Circular Signal Supplement*, dated and the ITE *LED Vehicle Arrow Traffic Signal Supplement*.

I. **Tests, Inspection, and Sampling.** Test each LED module and inspect before shipment. Reject pieces of equipment that fail to meet the requirements of this section.

J. **Drawings and Information.** Provide two copies of drawings of the signal head and LED module showing the manufacturer's part numbers.

Provide the independent test lab reports showing that proposed material meets or exceeds the requirements of this section and QA testing and Inspection per Section 6 of the ITE *LED Circular Signal Supplement* and the ITE *LED Vehicle Arrow Traffic Signal Supplement*. Failure to provide the independent lab test reports will be cause for rejection.

The Engineer will hold the information required by this subsection, along with a sample, if requested, as standards for acceptance.

921.04. Pedestrian Signals and Countdown Type

Provide pedestrian signals and countdown pedestrian signals meeting the requirements of the ITE *Adjustable Face Pedestrian Signal Heads* and *LED Performance Specifications of the Pedestrian Traffic Control Signal Indications (PTCSI)*, Part 2, “Pedestrian Traffic Signal Modules.” The pedestrian signal indications include the LED signal modules, countdown, socket assembly gaskets, reflector and door assembly, housing, visors, optical units, wiring, and mounting assemblies.

Provide LED pedestrian signal modules capable of displaying the ITE-specified symbolic full icon “hand” or “walking person” legends, using a one-piece section that includes a nominal message-bearing surface size of 12 by 12 inches.

Provide LED countdown pedestrian signal modules capable of exhibiting two seven-segment digital numerical digits that display the remaining time to clear the intersection and the traditional full icon “hand” or “walking person” legends using a one-piece section that includes a nominal message-bearing surface size of 16 by 16 inches.

A. **Housing.** Provide housing for each section as a one-piece, black polycarbonate resin material with front, sides, top, and bottom integrally molded. Provide housing at least $^{3}/_{32}$ inch thick, ribbed to produce a strong assembly and lightweight. Provide two sets of internal bosses in the section for mounting terminal strip facilities horizontally. Attach a six-position terminal block with screw terminals for spade lugs to bosses with two self-tapping stainless steel screws.

   Provide a 2-inch-diameter round hole in the top and bottom of each signal section to receive a 1½-inch supporting pipe. After assembling the sections, ensure that a 1-inch cable can pass through the head without being damaged or requiring excessive labor.

   Provide a variable pressure-type door latch, bolt, and wing nut of AISI 300 Series stainless steel or approved equal.

   Provide signal sections with a “hand” and “walking person” symbolic icon signal face with an overall height of at least 14 inches.

For fasteners partially or fully exposed on the exterior of the assembled housing, provide AISI 300 Series stainless steel fasteners. For other screws, bolts, nuts, and hinge pins on the interior of the housing, provide AISI 300 Series stainless steel, brass, or aluminum fasteners. Do not use plastic fasteners to secure the door.

B. **Visor.** Provide signal heads with visors that encompass the top and two sides of the lens for each signal indication. Provide a visor made of black polycarbonate resin at least 0.070 inch thick, attached to the door and signal section with at least four AISI 300 Series stainless steel screws. Provide a visor that fits tightly against the door and does not allow perceptible filtration of light between the door and the visor. Provide a visor that is detachable and 10 inches long or 6¾ inches long for countdown pedestrian signals. Provide a visor-mounting system that allows handling of the signal head by the visor.

C. **LED Module.** Provide new LED pedestrian signals of the latest models currently in production. Equipment that is no longer manufactured will not be accepted even if it meets the requirements specified in this subsection. Install all LED signals produced by the same manufacturer in one location.

Provide LED pedestrian signals that achieve the minimum intensity requirements of the ITE photometric test criteria.

1. **Physical and Mechanical Requirements**

a. **General.** Make each LED module a self-contained unit.

The LED module and the internal LED and electronic components must be able to withstand mechanical shock and vibration. Ensure that the LED signal manufacturer is ISO 9001 certified.

Provide an LED module that protects against dust and moisture intrusion in accordance the requirements of MIL 810F, Procedure I, “Rain and Blowing Rain” testing. Conduct the test on a stand-alone unit with no protective housing required.

Provide an LED signal module made of UV, stabilized polycarbonate. Provide LED signal modules with a lens that is tinted or uses transparency film or materials with similar characteristics. If requested by the Engineer, use a surface coating or film on a non-fused polymeric lens to provide front surface abrasion resistance.

Provide pedestrian signals with smooth external lens surfaces with no raised features to minimize the collection of dirt, soil, diesel

smoke, and other particulate contaminates and to facilitate periodic cleaning.

Identify each LED signal module with the manufacturer's name, model number, rated voltage, power consumption, and serial number on the outside of the unit. Ensure that the identification tag is visible without having to disassemble the signal module.

Provide LED signal modules with a prominent and permanent vertical indication to orient the module inside the pedestrian signal housing.

b. **LED Assembly**. Provide LED assemblies that consist of an LED array mounted to a printed circuit board and sealed in a polycarbonate cover assembly. Secure the cover assembly to a 12-inch polycarbonate, or 16-inch for countdown, clear matte signal lens. Provide the assembly with No. 18 AWG, anti-capillary, 39-inch, color-coded leads meeting the requirements of the NEC with insulated spade lug terminals for attachment to the signal terminal block.

The retrofit assembly requires removing the existing housing and mounting assembly and reconfiguring the mounting brackets to accommodate the one-piece LED pedestrian signal housing.

Provide retrofit replacement modules built for the PTCSI sizes of the "hand" and "walking person" icon pedestrian standards that fit into existing signal housings without modifying the housing.

Provide enclosed units that do not expose circuit boards with LEDs. Do not use screw-in type products.

c. **LED Array**. Provide LED arrays that consist of a highly visible full icon symbol of the "hand" and "walking person." Use a "hand" symbol that is at least 9 inches tall and consists of Portland Orange LEDs. Use a "walking person" symbol that is at least 9 inches tall and consists of Lunar White LEDs. Provide symbols that are at least 5¼ inches wide. Provide at least No. 18 AWG wires with thermoplastic insulation.

Provide an LED countdown array that consists of a highly visible full icon symbol of the "hand" and "walking person." Ensure that the "hand" symbol is at least 11 inches tall and consists of Portland Orange LEDs. Use a "walking person" symbol that is at least 11 inches tall and consists of Lunar White LEDs. Provide symbols that are at least 6½ inches wide. Provide units with countdown digits that are at least 9 inches tall and consist of two rows of

Portland Orange LEDs. Provide at least No. 18 AWG wires with thermoplastic insulation.

Provide Portland Orange T-1 LEDs that use aluminum indium gallium phosphate technology, 605 nanometers. Provide white T-1 LEDs that use indium gallium nitride technology.

2. **Electrical Requirements.** The minimum performance requirements for LED pedestrian signals and countdown modules include the following:

   a. LED signal modules that operate from a 60 hertz line frequency, over a voltage range from 80 to 135 VAC with a luminous intensity change no greater than ±10%.

   b. Provide a nominal operating voltage of 120 VAC root mean square for all measurements.

   c. Each LED signal module has two color-coded, minimum No. 18 AWG, 39-inch, 600-volt, jacketed wires meeting the requirements of the NEC and rated for service at 221°F. Provide the wire leads with pre-insulated spade lug terminals for connecting to existing traffic signal terminal blocks.

   d. LED signal modules include voltage surge protection to withstand high-repetition noise transients and low-repetition, high-energy transients as specified in Section 2.1.8 of NEMA Standard TS-2.

   e. LED circuitry prevents flicker at less than 100 hertz over the voltage range specified in Section 5.2 of the ITE LED PTCSI.

   f. LED signals and associated on-board circuitry meet the requirements of FCC regulations in 47 CFR Part 15, Subpart B, concerning electronic noise emissions.

   g. LED modules provide a power factor of at least 90 at the nominal rated voltage, at 77°F. The total harmonic distortion is less than 20% at the rated voltage, at 77°F.

   h. LEDs are connected in series parallel strings so LED burnouts result in a single point failure. The current draw ensures compatibility and proper triggering and operation of load switches.

   i. The maintained minimum luminance value for the LED modules' "walking person" icon remains at 2,200 candelas per square meter for at least 60 months.

   j. The maintained luminance value for the LED modules' "hand" icon remains at 1,400 candelas per square meter for at least 60 months.

k. Each module icon reaches 90% full illumination within 75 milliseconds of applying the nominal operating voltage.

l. Modules do not illuminate after 75 milliseconds of removing the nominal operating voltage.

Provide a six-point terminal block with stainless steel or chrome plated brass screw terminals for spade lugs for connecting wires from the LED module and incoming wires from the controller. Centrally locate the terminal block in the housing and provide at least 1 inch lateral clearance from the housing.

3. **Power Consumption and Operational Range**. Provide LED pedestrian traffic signals that consume no more than 8 watts for the "hand" icon, 10 watts for the "walking person" icon, and 8 watts for the countdown digits, at 120 VAC, 0.90 power factor at 77°F.

   Provide LED signals that operate over a temperature range from −40 to 165°F, with no more than a 10% change in luminous intensity over the required voltage range.

   Ensure that the luminance uniformity of the "walking person" and "hand" icons does not exceed a ratio of 1:10 from the minimum to maximum luminance values, as measured in ½-inch-diameter spots.

   If operating within the temperature range, ensure the luminance of the module does not exceed three times the minimum luminance of the modules.

   Provide LED pedestrian countdown modules with a uniform appearance when illuminated. Provide LED pedestrian countdown modules that do not present a pixilated appearance.

4. **Photometric Requirements**. Provide the minimum initial luminous intensity values for the LED traffic signal module specified in Section 4 of the LED Performance Specifications.

   Provide LED pedestrian signal modules meeting the minimum intensity requirements while operating over a temperature range from −40 to 165°F.

   Provide LED traffic signal modules with measured chromaticity coordinates that meet the requirements of Section 4 of the LED Performance Specifications.

   Retain a certified independent test lab to provide test data to verify that pedestrian signal performance meets the requirements of Section 6 of the LED Performance Specifications. To test, control and monitor the "walking person," "hand," and countdown digits separately, provide

three wires for electrical connection to the “walking person” and “hand.”

5. **Countdown Timer**. Provide a micro-controller-based countdown timer. Provide a timer that counts down only during the pedestrian clearance intervals, continuously monitors the pedestrian clearance interval, and automatically adjusts for changes made at the controller. If the flashing “hand” icon becomes solid, ensure that the module displays a zero for 1 second and then blacks out. Ensure that the countdown display remains dark until the beginning of the next countdown.

   If a pre-emption sequence begins, ensure that the countdown module skips the pre-empted clearance time and reaches zero at the same time as the flashing “hand” becomes solid. In the cycle following a pre-emption call, ensure that the signal displays the correct time. Ensure that the countdown remains synchronized with the signal indications and always reaches zero at the same time the flashing “hand” becomes solid.

   Provide the LED module with a removable plug on the rear of the unit to allow access to dip switches for selecting the following features:

   a. 1 – Display zero during standby;

   b. 2 – Turn on LEDs for testing;

   c. 3 – Countdown walk, plus clearance time; and

   d. 4 – Disable countdown display.

   Provide the countdown module with an internal conflict monitor to prevent conflicts between the “walking person” and the “hand” icons and the countdown digits display. Provide a conflict monitor that prevents the display from counting down during a steady “hand” indication.

D. **Electrical Wiring.** Provide electrical wiring that consists of stranded wire that meets the requirements of the ITE VTCSH. Equip each pedestrian signal with a barrier-type terminal block with at least three terminals: one for each optical unit and one common terminal.

   Mount the terminal block so it does not interfere mechanically with other components of the signal. Electrically and mechanically secure the wiring to a lamp receptacle. Insulate exposed current-carrying parts to prevent electrical shock hazard. Use pre-insulated fork-type terminals on the wires at the terminal block connection. Do not use pressure-type terminal blocks.

E. **Mounting Bracket Frame Assembly and Fitting.** Construct the mounting frame assembly and fittings entirely weathertight. Reference MDOT typical signal construction details to reflect the straight arm length needed for the countdown pedestals. Provide arms for the mounting assembly of 1½-inch standard steel pipe to provide the following dimensions, within a tolerance of ¼ inch:

1. For overhead and pedestal mountings, a radius of 8¾ inches from center of hub to center of pipe cross; and
2. From the center of the first pipe cross, 11½ inches for I-brackets and T-brackets and 14½ inches for countdown brackets.

Ensure that the internal surfaces of pipes and fittings are free of sharp edges and burrs. Use ferrous pipe crosses to make right angles in the mounting assembly. Close unused openings of the pipe crosses with ornamental closures. Provide malleable iron adapters or slip fitters.

Provide malleable iron fittings free of flash and voids.

Install a plastic thread protector on exposed pipe threads to protect the threads from damage during shipping.

F. **Painting Requirements.** Before painting the mounting brackets, clean and treat the ferrous and aluminum surfaces in accordance with standard industry practice for each type of metal to ensure bonding of the paint to the metal.

Provide a coating system for the mounting bracket assembly consisting of durable and weather-resistant black enamels, applied at a uniform thickness without blisters, runs, or other defects. Provide an average dry film thickness of 1.5 mils as determined by Method A, Inductance Thickness Gauge, as specified in ASTM D1400.

Provide black LED pedestrian traffic signals. Provide visors with an inside surface painted flat black, compatible with polycarbonate plastic.

Provide signal parts with a color and finish that does not require painting to maintain a functional appearance. Ensure that scratches on signal parts do not expose uncolored material.

Clean and pretreat metal surfaces of pedestrian signal mounting brackets before painting and assembly to ensure that the phosphate coating bonds to the surfaces in accordance with Federal Specifications TT C 490, “Cleaning Methods and Pretreatment of Ferrous Surfaces or Organic Coatings.”

Use semi-gloss or glossy black enamel to finish coat other exterior surfaces of the fittings, except stainless steel latch bolts and clips.

G. **Packing and Marking.** Pack each pedestrian signal separately to prevent damage to the pedestrian signal and mounting assembly during transportation to the project. Mark each carton legibly with the pedestrian signal and mounting assembly description and supplier's name.

H. **Quality Assurance.** Provide LED modules that comply with the QA production testing, inspection, and design specified in the ITE LED PTCSI, Part 2, "Pedestrian Traffic Signal Modules," adopted in 2004.

I. **Tests, Inspection, and Sampling.** Test each LED and inspect for conformance with this section before shipment. Reject pieces of equipment that fail to meet the requirements of this section. Ensure that a certified independent test lab provides test data to verify that the pedestrian signal performance meets the requirements of Section 6 of the ITE LED PTCSI.

J. **Drawings and Information.** Provide two copies of a detailed drawing and material specification list of the pedestrian head.

Provide LED pedestrian signal modules that comply with the QA production testing and inspection requirements specified in Section 6 of the ITE LED PTCSI.

Provide a test report in accordance with subsection 921.04.I from an independent lab certifying that the pedestrian signals meet the requirements of the ITE LED PTCSI.

The Engineer will hold the information required by this subsection 921.04.J, along with a sample, if requested, as standards for acceptance.

921.05. Traffic Signal Strain Pole

A. **Foundation**

1. Steel reinforcement for all drilled shafts must be in accordance with section 905.
2. Concrete mix must be in accordance with Division 10.
3. Slurry must be in accordance with section 1004.
4. Conduit material must be in accordance with section 818.
5. Anchor bolts, nuts, washers, and lock washers must be in accordance with subsection 908.14.A and 908.14.C, including the elongation and reduction of area requirements listed in Table 908-1 of subsection 908.14.B.

B. **Shaft and Base.** Provide traffic signal strain poles fabricated from steel meeting the requirements of ASTM A595/A595M, Grade A, with a yield

point (fy) of 55 kips per square inch (ksi) or ASTM A572/A572M, Grade 50 steel, fy of 50 ksi. Base material must meet the requirements of ASTM A36/A36M.

Provide a tapered shaft with a circular or at least an eight-sided polygonal cross section. Shafts may be multi-ply.

Provide a pole top with means for securing to the top of the shaft.

Provide a hook or other device for supporting a cable on the inside of the shaft near the top.

Provide each pole with three pole bands for attaching the traffic signal span, minor cable span, and service rack. Attach only one of the spans or racks to each pole band.

C. **Strength Requirements.** Provide a standard capable of withstanding a transverse load of at least 3,700 pounds applied 18 inches below the top of the shaft without exceeding the elastic limit. Ensure that the deflection of the shaft does not exceed 0.40 inch per 100 pounds of transverse load applied at the same point.

D. **Identification of Manufacturer.** Provide standards with a catalog or other manufacturer's identification number permanently marked on the base.

921.06. Traffic, Pedestrian Signals, Pushbutton Pedestals

Provide pedestals for mounting pedestrian pushbuttons with signs or traffic and pedestrian signals. Equip poles over 11 feet tall with support bracket for 4-inch nominal size pipe.

Provide pedestals of the overall height shown on the plans or as directed by the Engineer.

Provide pedestals meeting the minimum requirements of this subsection and the special details.

Provide a pedestal made with an aluminum shaft threaded into a cast aluminum base. Secure the shaft by a stainless steel set screw to prevent loosening or turning after installation. Provide lug for grounding connection within the pedestal base.

A. **Shaft.** Provide extruded aluminum pedestal shafts meeting the following characteristics:

1. Aluminum alloy meeting the requirements of ASTM B308/B308M;
2. Tensile strength of 30 ksi;
3. Yield strength of 25 ksi;

4. Elongation of 10%;
5. Walls 0.237 inch thick; and
6. OD of 4½ inches.

Provide threaded and de-burred pedestal shafts that conform to the basic dimensions of ASME B1.20.1 for National Pipe Thread Tapered (NPT). Ensure that the threaded end of the pedestal shaft has 4 inches of NPT thread. Coat threads with anti-seize grease before assembly. Equip pushbutton pedestals with a standard 4-inch cap.

B. **Finish.** Do not paint aluminum pedestals. Provide aluminum shafts with the minimum finish requirements specified in this subsection.

1. **Finish Type.** Provide a shaft with the full length covered with a tough surface texture that is not a mill finish, consisting of a uniform grain pattern perpendicular to the axis of the shaft.
2. **Texture Profile.** Ensure that the grain profile has a surface roughness of at least two but no greater than four times a roughness average (Ra) of 250 microinches. Provide aluminum pedestal shafts free of the following:
    a. Excessive material;
    b. Heat discoloration of material;
    c. Irregular grain spacing and grain patterns;
    d. Waviness;
    e. Scratches or marks of varying depths and sizes;
    f. Holes;
    g. Ridges;
    h. Cracks; and
    i. Other surface defects not removed in the finish process.

C. **Mill Certification.** Require the manufacturer to maintain reports and provide copies to the Department on request.

D. **Hardware.** Provide foundation bolts with a minimum diameter of ¾ inch, 21 inches long, and with a 3-inch L-bend on the unthreaded end.

Equip foundation bolts with hexagonal nuts and washers. Ensure that the threaded end of the bolts are threaded a minimum of 3 inches. Electro-galvanize bolts after threading in accordance with ASTM B633, Service Condition 4, for the entire length or hot-dip galvanize in accordance with ASTM A153. Provide nuts that are galvanized using

similar methods as used on the bolts, and ensure that nuts turn freely on the bolts after galvanizing. Provide a level foundation surface to accept the base assembly.

Attach the access door in the base of the pedestal with AISI 300 Series stainless steel machine screws.

E. **Drawings.** Provide two copies of detailed dimensional and installation drawings to the Engineer.

F. **Packaging.** Provide a protective cap for the threaded end of bolts to prevent thread damage. Provide a cardboard sleeve that covers the entire length of shaft to protect surface finish.

921.07. Illuminated and Non-illuminated Case Signs

Provide LED case signs internally illuminated by LEDs and changeable message case signs internally illuminated with LED light sources. Ensure that signs are designed to operate on 120-volt, single-phase, alternating current electrical systems. Work includes a retrofit unit capable of removing and replacing the LED light module and the associated material of an existing internally illuminated case sign.

Provide non-illuminated case signs equipped with retroreflective case sign panels.

Ensure well-fitted, free-moving doors and other moving components.

A. **Hardware.** For fasteners partially or completely exposed on the exterior of case signs, provide AISI 300 Series stainless steel fasteners. Provide a mounting hub for case signs of 1½ inch, malleable iron, KK-197, four-bolt mounted on the top center of the sign.

B. **Housing and Door Requirements**

1. **Housing for LED and Non-Illuminated Case Signs.** Provide one-way and two-way housings constructed of a minimum 0.080-inch-thick extruded aluminum.

   Provide four-way housings constructed with a minimum 0.063-inch-thick aluminum body and a 1½- by 1½- by ⅛-inch-thick channeled aluminum framework.

   Place a 1-inch, screened drain hole at each of the four corners of the housing bottom.

2. **Housing for Changeable Message LED Case Sign.** Provide case sign housing constructed of a minimum 0.125-inch-thick extruded aluminum with a 0.063-inch-thick flat aluminum back welded at the back.

Provide a back capable of being inserted into a slot designed in the backside of the extrusion. Ensure that the slot directs water out of the housing. Ensure that corners are tungsten inert gas (TIG) welded to provide a weatherproof seal around the entire housing.

3. **Doors for LED Case Signs.** Provide doors constructed of a minimum 0.080-inch-thick extruded aluminum for four-way, one-way, and two-way case signs. Fasten doors to the housing by a full-length stainless steel hinge. Secure doors onto a 1-inch-wide by $^{5}/_{32}$-inch-thick neoprene gasket with one or two ¼ turn Link Locks.

4. **Doors for Non-Illuminated Case Signs.** Provide doors constructed of a minimum 0.080-inch-thick extruded aluminum. Fasten doors to the housing by a full-length, 0.040- by 1½-inch open stainless steel hinge. Secure doors onto a 1-inch-wide by $^{5}/_{32}$-inch-thick neoprene gasket with one or two ¼ turn Link Locks.

   Provide single- or double-sided signs with a hinged, extruded aluminum service door to provide access to either side for service.

5. **Doors for Changeable Message Case Signs.** Provide doors constructed of 0.125-inch-thick extruded aluminum. Ensure that two corners are TIG welded and two corners screwed together to make one side of the door removable for installation of the Fiber Optic Module. Fasten the door to the housing on the left using a full-length, 0.040- by 1¼-inch open stainless steel hinge. Secure the door onto a 1-inch-wide by $^{5}/_{32}$-inch-thick neoprene gasket using two ¼-turn Link Locks.

   Provide single- or double-sided signs with a hinged, extruded aluminum service door to provide access to either side for service.

   Ensure that the sign door allows full access to serviceable components of the sign.

   Fit a three-sided visor made of 0.63-inch-thick aluminum to the door.

C. **LED Case Sign Electrical Requirements.** Provide an LED case sign designed to operate on 120 VAC, 60 hertz, single phase. Ensure that the LED current operates at the manufacturer's recommended current and voltage.

   Where conductors pass through sheet metal or conduit, provide bushings, grommets, or rolled edges on the edges of openings to protect conductors from abrasion. Provide a toggle switch as a disconnecting means.

   1. **LED Light.** Provide LED light consisting of LEDs that provide at least 250 candelas per square meter or an equivalent surface luminance of 1000 lux over an ambient temperature range from −40 to 165°F,

consistent with the NEMA temperature specifications. Ensure that the LED lights contain a quantity of white LEDs to uniformly illuminate the viewing area.

Provide LED light modules that consist of a circuit board composed of an insulated aluminum substrate, at least 0.050 inch thick, where LED modules are used.

Ensure that the LED light operates for at least 50,000 hours with a lumen depreciation no greater than 30%. Ensure that the LED supplier provides operational documentation, if requested, based on actual temperature measurements taken after 12 continuous hours of operation, correlated against lumen depreciation and LED mortality curves.

Where LED modules are used, ensure that the LED light module electronics are entirely coated with at least a 0.002-inch dry coat to protect the light module from moisture and corrosion. Ensure that LED modules are compliant with reduction of hazardous substances.

Where LED modules are used, attach the LED light module to the case sign housing to allow the module to remain in place during maintenance or retrofit activities. Ensure that the LED light module passes the tests specified in subsection 921.07.C.1.a and subsection 921.07.C.1.b, in accordance with the NEMA standards.

Where LED modules are not used, install two Edison-base sockets: one at the top and one at the bottom of the sign frame.

a. **Thermal Shock Test.** Perform the thermal shock test on LED light modules at temperatures of 85°F and −40°F for five cycles of 2-hour dwells with a 2-hour presoak at −40°F.

b. **Salt Spray and Soak Test**. Ensure that the LED light module endures 48 hours of continuous salt spray and 240 hours of saltwater soak.

   Ensure that the manufacturer burns-in LED light modules for 24 hours and certifies for compliance. Ensure that the manufacturer mounts a QC tracking sticker and the manufacturer’s name and date of manufacture on the inside of the LED light module.

   Ensure that the LED light modules do not exceed a 59°F temperature rise under continuous operating conditions.

   Paint the panels white and ensure that panels meet GM4901 specifications.

2. **Power Consumption and Power Supply Panel.** Provide LED case signs with the maximum power consumption wattage as follows:

Table 921-3:
LED Case Sign Maximum Power Consumption

Case Sign Size	Power Consumption (watts)
1-way 12 × 27 inch	15
4-way 12 × 27 inch	60
1-way 24 × 30 inch	45
2-way 24 × 30 inch	90
4-way 24 × 30 inch	180

Where LED modules are used, provide at least 75-watt power supply units rated by the UL for Class 2 operation, 24 volts DC, and Ingress Protection (IP66) rated.

Provide a terminal block for the incoming 120 VAC power. Where LED modules are used, connect the output of the 24-volt power supply to a two-wire connector that attaches to the LED light modules.

3. **LED Retrofit Assembly.** Provide LED retrofit assemblies meeting the requirements of this subsection that do not alter the structural properties or functional requirements of the case sign.

D. **Changeable Message Case Sign Electrical Requirements.** Provide changeable message signs capable of displaying three distinct fiber-optic-type messages. Provide the case sign, hardware, fittings, cable, and one message that is clearly and legibly displayed under any lighting conditions when energized. Refer to the FHWA and *Michigan Manual of Uniform Traffic Control Devices* (MMUTCD) legends for single- or multi-message overlays.

Provide a changeable message sign that forms the message with a single or double row of fiber optic glass bundles. Provide energized bundles that are highly visible within a 60-degree cone, centered around the optic axis.

1. **Fiber Optic Module.** Provide a fiber optic module consisting of a flat black, aluminum alloy, 3003 H14 faceplate, 0.080 inch thick, with the fiber optic assembly directly mounted to it. Insert the assembly into the rear track of the extruded aluminum door.

Secure glass, fiber optic bundles into an end tip using epoxy at the termination end and the common assembly at the other end. Grind smooth and optically polish to ensure maximum light transmission through the bundle.

Insert the end tip of black nylon into a punched hole in the black faceplate and mechanically hold in place with four crush ribs along the OD of the end tip. Ensure that the end tip, if installed on the faceplate, does not protrude more than $^{5}/_{16}$ inch.

Ensure that the LED light sources provide the message colors. Provide LED light sources capable of being changed in the field by replacing the solid state LED lamp without removing the sign from the case. Mount the LED light source with four No. 8 × ⅜ stainless steel screws between the common assembly and the LED lamp. Provide LED light sources that sustain an average 50,000-hour life.

Provide messages illuminated by at least two light sources, based on the message. Arrange the glass bundles so if one light source fails, the other sources continue to provide a legible message by lighting every other point in the message. Ensure that no color appears in the output points if the source is not energized, regardless of ambient light condition.

Provide messages that are clearly legible under any lighting conditions. Ensure that the sign is highly visible at full intensity within a 20-degree cone, centered around the optic axis.

Provide a ⅛-inch-thick matte or clear polycarbonate lens with anti-glare characteristics to protect the LED assembly. Insert the lens into the front track in the door.

2. **Lamps and Drivers.** Use solid state LED lamps to illuminate the messages. Use two lamps per message to provide failsafe operation in the event of lamp failure.

   Provide a 5-watt, LED type, or Department-approved equal LED lamp based on an MR 16 traditional halogen package rated for 50,000 hours of life.

   Where LED drivers are used, provide LED drivers to reduce the incoming 120 VAC to the lamp manufacturer's suggested operating voltage and current. Provide UL Class 2 rated LED drivers that operate at temperatures from −40 to 176°F. Provide LED drivers rated for 50,000 hours of life. Ensure that LED drivers provide a consistent light output across the line and load levels. Use a separate LED driver with each lamp to provide failsafe protection.

   Provide a barrier-type terminal strip, Weco 324/HDS/12-type, or Department-approved equal for electrical connection of field wires.

   Provide signs capable of continuous operation in temperatures from –35 to 140°F.

Include supplementary markings to indicate the correct method of connection for the leads.

E. **Face**

1. **LED Case Sign.** Provide an LED case sign face that is Lexan translucent white or other Department-approved plastic material with equivalent or better weathering, structural, and optical properties.

   Provide a face that is 0.125 inch thick ±10%. Mark each face with the plastic name or trade name.

   Provide sign faces with a message applied to the outside. For black sign copy, provide 3M Company, Scotchcal, ElectroCut Film No. 7720 12, and for red copy, provide 3M Company Scotchlite, ElectroCut Film (E.C. Film) No. 1172, or Department-approved equals.

2. **Changeable Message Case Sign.** Provide changeable message case sign faces designed to clearly and legibly display three distinct fiber optic messages, one message at a time, when energized under any lighting conditions. Refer to standard FHWA and MMUTCD legends to provide a single- or multi-message overlay.

   Form the message with single or double rows of fiber optic glass bundles. Ensure that the energized bundles are highly visible within a 60-degree cone centered around the optic axis.

3. **Non-Illuminated Case Sign Panel.** Provide non-illuminated case sign panel sections meeting the requirements of subsection 919.02.C. Provide reflective sheeting material meeting the requirements of ASTM D4956 for Type IX retroreflective sheeting.

   Provide one-piece case sign panel sections of Type III aluminum sheet with no vertical splices.

   Apply the reflective and non-reflective legends in accordance with the sheeting manufacturers' recommendations. Provide legends that display one symbol or text message.

   Insert the case sign panel into the front track in the door.

   For sign panels without legends, provide aluminum panels. Coat the exterior face with a semi-gloss or gloss yellow enamel. Provide a color within the limits shown on FHWA's Highway Yellow Color Tolerance Chart for the central color, except provide a color darker than the central color. Coat the interior face with a semi-gloss or gloss white enamel.

F. **Wiring.** Provide illuminated case signs completely wired. Provide 600-volt, No. 18 AWG soft annealed copper wiring with the following characteristics:

1. Color coded;
2. At least seven strands; and
3. Insulation of 194°F thermoplastic high heat-resistant nylon coated (THHN) thermoplastic or 194°F neoprene and marked.

Provide wiring that runs neatly in flexible aluminum conduit between the power supply and the socket housing. Where conductors pass through an opening in sheet metal or conduit, provide bushings, grommets, or rolled edges to protect conductors.

Make splices and terminations at the terminal block, switch, lampholder leads, or ballast leads. Make splices mechanically and electrically secure using insulated pressure-type, solderless connectors. Make terminations mechanically and electrically secure using insulated pressure-type solderless terminals. Provide stainless steel or nickel-plated brass wire connecting screws, tabs, washers, and strips.

Mount switches and prevent them from turning by providing mechanical means other than friction.

G. **Painting Requirements.** Before painting the case sign, clean metal surfaces and surface treat in accordance with standard industry practice to ensure that paint bonds to the metal.

Provide a coating system consisting of durable and weather-resistant enamels applied in a uniform thickness, without blisters, runs or other defects. Provide an average dry film thickness of 1.5 mils, determined by Method A, “Inductance Thickness Gauge,” as specified by ASTM D7091, “Measurement of Dry Film Thickness of Nonmagnetic Coatings of Paint, Varnish, Lacquer, and Related Products Applied on a Nonmagnetic Metal Base.” Coat the metal interior of the sign with a semi-gloss or gloss white enamel.

Coat the exterior of the sign with a semi-gloss or gloss yellow enamel. Provide a color within the limits shown on FHWA’s Highway Yellow Color Tolerance Chart for the central color, except provide a color darker than the central color.

H. **Packing and Marking.** Provide finished signs with a permanent legible marking that includes the supplier’s name, trademark, or other means of identification.

Package signs individually to prevent damage to the sign during transportation. Mark each package is legibly with the descriptions of contents and supplier's name.

I. **Inspection.** The Department will perform inspections of illuminated and non-illuminated case signs. Provide mill test reports for aluminum extrusions upon the Department's request.

At the time of delivery, ensure that the supplier provides a general certification, stating that materials meet pretreatment requirements, as specified by subsection 921.07.G. Ensure that the certification references the method and material used in the pretreatment process.

921.08. Traffic Loop

A. **Traffic Loop Wire.** Provide loop wire and loop lead-in wire meeting the requirements of subsection 918.03.

B. **Traffic Loop Sealant.** To seal and encapsulate detector loop wires in concrete or HMA roadway surfaces, provide sealant in cartridges for use with a common 1-quart manual caulking gun or air-powered caulking gun. Provide sealant meeting the following requirements:

1. Consists of one part moisture curing and self-leveling polyurethane, not containing a level of solvents that would cause an incompatibility with asphalt. If installing traffic loop in existing pavement before placing a final asphalt wearing course, provide sealant compatible with the asphalt wearing course.
2. Minimum temperature range for application from 40 to 100°F and a minimum service temperature range from −40 to 200°F.
3. Dielectric constant greater than 6 at 50 hertz and greater than 4 at 500 hertz or greater.
4. Viscosity from 28,000 cPs to 48,000 cPs, tack free within 24 hours or less after application.
5. Non-stringing and capable of opening to traffic immediately after sealant recesses ⅛ inch.
6. Provides complete encapsulation of the detector loop wires in a rubber-like environment and provides protection against moisture, wire and thermal pavement movements, and damage under normal roadway conditions.
7. Moisture cure to a tough, long-lasting seal that resists weather, abrasion, oils, gasoline, anti-freeze solutions, brake fluids, and road salts and other deicers.

8. Remains permanently flexible without shrinking or pulling out of the saw-cut groves after application. Ensure that cured sealant is temperature stable throughout the specified minimum service temperature range without performance degradation.

C. **Packaging and Marking.** Deliver materials in the original, tightly sealed containers, clearly labeled with the manufacturer's name, product identification, and lot number. Pack each case of cartridges to prevent damage to the cartridges during transportation to the project. Mark each carton legibly with a description of the contents and the supplier's name.

921.09. Digital Loop Detector

Provide digital loop detectors meeting current and applicable NEMA standards. Provide high performance, four-channel, inductive-loop vehicle detectors with liquid crystal displays (LCDs) to indicate the operational, setup, and loop diagnostic parameters of the loop detector system in accordance with the minimum design, operational, and functional performance requirements specified in this subsection.

A. **Detector Loop Requirements.** Provide detector units meeting the environmental, transient, and size requirements of NEMA Standards TS-1 1994, Section 15, and TS-2, 2003, Section 6.5.

Provide microprocessor controlled, fully digital, self-tuning detector units with four operationally independent channels. Ensure that the detector unit is configured as a rack-mounted printed circuit board for insertion into a NEMA TS-1 or TS-2 rack.

Provide a detector with optically isolated, solid state outputs designed to provide a continuous fail-safe output in the event of power loss to the unit. Ensure that each channel provides a continuous fail-safe output and indication in response to an open or shorted loop.

Provide a detector that uses two spring-loaded toggle switches per channel to set up and retrieve information from the detector.

Provide a detector unit that displays and records open loops, shorted loops, or an excess inductance change greater than 25%. Program the LCD and yellow fault LED to display the type of error. Program the LCD to display "Shorted loop," "Open loop," or "25% DL/L," and log the most recent 25 events. Provide units that store the information in non-volatile memory.

Ensure that each channel includes two wide-angle, high-visibility LED indicators.

Provide channels with a red LED to display channel detect output status, output state, and the status of the delay and extension timers, plus a yellow LED to display loop fault monitor diagnostics.

Ensure that the red channel detect LED indicator flashes at a rate of 2 hertz during delay timing and flashes at a rate of 4 hertz during extension timing.

Ensure that the yellow fault LED flashes once to indicate an open loop, twice to indicate a shorted loop, and three times to indicate an excessive change in inductance.

During fault indication, ensure that the red channel detect LED flashes at the same rate as the yellow fault LED to indicate a current fault. If the fault self-heals, ensure that the red LED returns to normal operation and the yellow fault LED continues to flash, indicating a prior fault.

B. **Graphic Liquid Crystal Display.** Provide a graphic LCD unit capable of displaying four channels simultaneously.

Provide a unit capable of setting up channels simultaneously and resetting channels individually.

Provide a unit that uses a white backlight for the LCD. Do not provide units with electro-luminescence.

C. **LCD Full Prompting Menu System.** Provide an LCD unit that prompts the user with word prompts in English for easy setup, operation, diagnostic, and information-gathering operations.

Provide a menu system that prompts the end user for the input specified in this subsection during setup and operation.

1. **Sensitivity.** Ensure that the LCD prompting menu offers a range of sensitivity values from 1 to 15 and an “OFF” option that disables the channel. Provide a system that displays a pie chart showing the deflection caused by vehicles on the loop to assist in determining the correct sensitivity and an XY chart showing the deflection values and vehicle calls over time.

2. **Frequency.** Provide an LCD prompting menu that displays eight frequency values that the user can select from, depending on the frequency of adjacent loops. Ensure that the actual frequency is displayed and can be compared to adjacent detectors to achieve maximum separation between adjacent loops. Provide a unit capable of graphically displaying noise or crosstalk on the display.

3. **Operational Mode.** Provide an LCD prompting menu that allows users to select one of two operational modes: “Pulse” or “Presence.”

For a selection of “Presence,” program the unit to prompt the user for “Short,” “Long,” or “User-Defined Presence.”

4. **Timing.** Ensure that the timing menu for “Delay” and “Extension” prompts the user for a “yes” or “no” response. For a selection of “yes,” program the unit to prompt for the delay amount and extension timing.
5. **Count.** Provide a count that controls the secondary count outputs and prompts the user for a “yes” or “no” response. For a selection of “yes,” program the unit to prompt the user for the loop configuration from which it will take the counts and if secondary count outputs are active.
6. **Approach ID.** Program the unit to prompt the user to select alpha-numeric characters to identify the related approach of the channel (e.g., SBLT for southbound left turn).
7. **Display.** The “Display” selection determines the display that shows during normal operation at power up. Program the unit to prompt the user for frequency (FREQ), inductance (INDUCT), and count (COUNT). Ensure that pressing “down” cycles through the display options.
8. **Event Logs.** Ensure that selecting “Logs” allows the user to view the last 25 events per channel with the most recent first. Provide a log with the type of fault, power up, power loss, and reset events and the time elapsed after each event.

D. **Edge Connector Description**

Table 921-4:
Edge Connector Description

Pin No.	Function
A	DC Supply – (Logic Ground)
B	DC Supply + (12 VDC – 24 VDC)
C	Reset
D	Loop Input Channel 1
E	Loop Input Channel 1
F	Call Output Channel 1 (Collector)
H	Call Output Channel 1 (Emitter)
J	Loop Input Channel 2
K	Loop Input Channel 2
L	Earth Ground
S	Secondary Count Output Channel 1
W	Call Output Channel 2 (Collector)
X	Call Output Channel 2 (Emitter)
Y	Secondary Count Output Channel 2

Table 921-4 (cont.):
Edge Connector Description

Pin No.	Function
1	Green Input Channel 1
2	Green Input Channel 2
7	Status Output Channel 1
20	Status Output Channel 2

E. **Operation Requirements.** Provide detector units designed to operate over a voltage range from 10.8 to 28 VDC. Provide a power supply that operates over a voltage range from 10.8 to 28.8 VDC and at no greater than 90 milli-amperes for backlight illuminated units. Provide detector units with the following characteristics:

1. Loop tuning range from 20 to 2500 microhertz, plus a lead-in from 15 to 60 kilohertz;
2. Q factor of 5 minutes;
3. Low (true) inputs of less than 8 volts and high (false) inputs greater than 16 volts;
4. Solid state, optically isolated call output. Ensure that the “On” voltage is less than 1.5 volts at 50 milli-amperes collector current;
5. Status and count outputs no greater than 50 volts collector voltage, with an “On” voltage less than 1.5 volts at 50 milli-amperes collector current;
6. The following physical dimensions:
   a. 7- by 4.5-inch international card with 44-pin, double-sided gold-edge connector, and
   b. 1.12-inch-wide faceplate with a 3- by 1-inch handle;
7. Weight of 1 pound; and
8. Functional from −29 to 165°F at a maximum non-condensing humidity of 95%.

F. **Functional Data and Parts Lists.** Ensure that the manufacturer provides a complete set of the following items with each loop detector, directly applicable to the loop detector with which the item is supplied:

1. Schematic and wiring diagrams of the loop detector and terminal facilities,
2. Instructions for loop detector installation and maintenance, and

3. Parts list.

G. **Packing and Marking.** Package each loop detector separately to prevent damage to the loop detector during transportation. Mark each carton legibly with the loop detector description, contract number, and supplier's name.

921.10. Steel Truss Arms

Provide steel truss arms for mounting video detection cameras and radio antennas as shown on the plans and in accordance with this subsection.

A. **Truss Brackets.** Provide truss brackets formed from round tube and steel bar or plate, complete with stainless steel U-bolts, nuts, and washers for mounting to steel poles or curved plate with bolt holes for mounting to wood poles. Provide trusses with an 18-degree rise in the top arm tube from the mounting plate to the location of the device attachment. Locate a ⅞-inch rubber grommet within 3 inches of the mounting base plate on the underside of the upper arm tube.

B. **Truss**

1. **Wood Pole Mount.** Provide arm tubes meeting the requirements of ASTM A500/A500M for Grade B steel, with 2⅞ inch OD by 0.203-inch-thick tubing overlapped and welded to 2⅜ inch OD by 0.154-inch-thick stock tubing for 16-, 18-, and 20-foot arms, or 2⅜ inch OD by 0.120 inch thick for arms no longer than 15 feet.

   To form the truss, weld ½- by 2-inch flat bar steel meeting the requirements of ASTM A36/A36M between arm tubes. Provide a pole-mounting plate formed using ⅜-inch ASTM A36/A36M steel plate and plate gussets welded to the arm tubes in accordance with the mounting plate detail shown on the truss arm drawing.

   Provide one plate per arm tube. Ensure that each plate incorporates two 0.562-inch-diameter holes and one 0.687- by 1.50-inch keyhole for lagging to the wood pole.

2. **Steel Pole Mount.** For 1½-, 4-, 6-, 9-, 12-, 15-, and 18-foot arms, provide arm tubes meeting the requirements of ASTM A500/A500M for Grade B steel with 2⅜ inch OD by 0.120-inch-thick tubing, welded to ¼-inch formed steel mounting plate meeting the requirements of ASTM A36/A36M.

   To form the truss, weld ½- by 2-inch flat bar steel meeting the requirements of ASTM A36/A36M between arm tubes. Provide ¼-inch flat bar steel gussets welded between the arm tube and mounting plate.

Use steel U-bolts and other hardware meeting the requirements of ASTM A36/A36M to attach trusses to the steel pole. For poles with a diameter range from 8½ inches to less than 9⅛ inches, use ⅝-inch rod bolts. For poles with a diameter range from 9⅛ inches to 10¼ inches, use ¾-inch rod U-bolts. Use hex nuts, flat, and lock washers for fastening U-bolts.

C. **Finishes.** Provide truss arms, brackets, and hardware, hot-dip galvanized after fabrication and welded in accordance with ASTM A123/A123M and ASTM A153/A153M. Weld in accordance with AWS D1.1.

921.11. Mast Arm Mount Signal Bracket

Provide adjustable mast arm mount signal brackets in accordance with Figure 921-1 and this subsection.

A. **Adjustability.** Ensure that the bracket is adjustable as shown in Figure 921-1, A through D.

B. **Attachment.** Provide the bracket with Type 201 stainless steel band to fasten the bracket to the supporting arm or structure. Provide an easily adjustable bracket to fit all sizes of round, octagonal, elliptical, or other shaped structure without special tools or equipment.

C. **Signal Accommodations.** Attach the bracket to the signal by clamping the signal from the top and bottom to ensure maximum rigidity. Provide a standard bracket, as shown in Figure 921-1, to accommodate all major signal manufacturers' signals ranging from a three-section, one-way, 8-inch signal to a three-section, one-way, 12-inch signal or a combination of sizes including 3M and International Code Council (ICC) configurations.

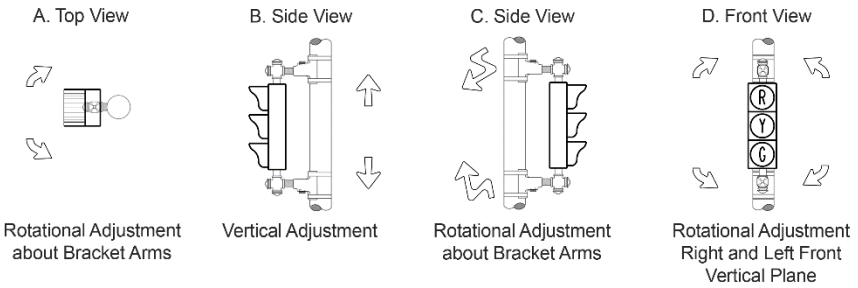

Figure 921-1: Signal Head Bracket Adjustment

Ensure that the electrical wiring is concealed in the bracket. Provide a gusseted, C-shaped, extruded aluminum tube for the vertical support to accommodate the signal cable, regardless of the vertical position of the tube.

D. **Material and Design.** Provide upper and lower arms cast from 319 aluminum or a Department-approved equal. Ensure that the lower bracket arm is internally threaded to accommodate the threaded vertical support tube. Provide the lower arm with acrylonitrile-butadiene-styrene plastic covers that will slide and snap into position without fasteners or tools. Ensure that the upper and lower arms have 72-tooth serrations cast into the arm to ensure a positive lock with the signal housing, secured around the rotational axis with setscrews. Provide upper and lower arms with a tri-bolt arrangement for attachment to the signal housing. Ensure that the lower arm has an opening to accommodate at least three 12-conductor 14-gauge cables.

E. **Vertical Support Tube.** Provide a double-gusseted, extruded 6082-T8 aluminum alloy tube for the vertical support with the cross section shown in Figure 921-2. Provide each tube with a vinyl closure strip, threaded on one end to accommodate the lower arm assembly.

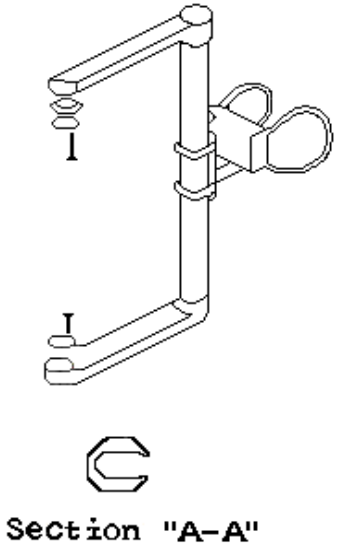

Figure 921-2: Section “A-A”

F. **Mast Arm Clamp Assembly.** Provide a mast arm clamp assembly with male and female halves cast from 356-T8 aluminum alloy or a Department-approved equal. Ensure that the male clamp half is secured in the female half using a spring steel retainer ring. Ensure that the assembly provides an unobstructed center of at least 2 inches in diameter to allow for 360-degree rotation of the clamp assembly. Ensure that no internal cross-bracing assembly obstructs the center opening.

Provide a mast arm clamp assembly equipped with galvanized steel cable, $^{7}/_{16}$-inch diameter.

G. **Hardware.** Provide each bracket with required bolts, washers, gaskets, and other hardware to attach the signal to the bracket and the bracket to the mast arm.

H. **Finish.** Provide aluminum parts with an Alodine 1200 finish or Department-approved equal.

Provide steel parts with a yellow, zinc dichromate finish.

921.12. Antenna

Where installation of new equipment is called for on the plans, provide material in accordance with section 918 and this section.

A. Configure the 10 dB Yagi antennas for a back-to-back operation, specified for the frequency range of the radio, and connect a Pasternack PE-2047 or Encom Wireless EP-Splitter type power divider, or approved equal, for the master and repeater locations.

B. Use a 10 dB Yagi antenna, specified for the frequency range of the radio, for the remote location.

C. Use a Times Microwave LMR or Andrew CNT 400 DB type cable, or approved equal, for connection between both the polyphaser and power divider and the power divider and antenna for the master and repeater locations.

D. Use a Times Microwave LMR or Andrew CNT 400 DB type cable, or approved equal, between the polyphaser and the antenna for the remote location.

E. Use Times Microwave TC-400-NMH or RF Industries RFN-1006-31 Type N male connectors, or approved equal, and fasten at the ends of the LMR or CNT 400 DB type cable for connection to the polyphaser, power divider, and antenna.

DIVISION 10 – CONCRETE MIXTURES

NOTES

Section 1004. Portland Cement Concrete Mixtures

1004.01. Description

Concrete must consist of a mixture specified by the grade of concrete of portland cement or blended portland cement; fine aggregate; intermediate aggregate, when required or permitted; coarse aggregate; water; and admixture, when required or permitted.

1004.02. Materials

Provide materials in accordance with the following:

Select aggregates for the required grade of concrete in accordance with Table 1004-1.

Stone sand 2SS is not permitted in concrete exposed to vehicular traffic.

1004.03. General Requirements

A. **Mix Design and Documentation.** Design concrete mixtures meeting the requirements of Table 1004-1. Provide the grade of concrete for the section number reference application specified in Table 1004-1 or as specified in the contract. Concrete grades ending in HP signify high-performance concrete.

Variance requests must be submitted in writing and must include the mix design, JMF, and associated trial batch verification test data. Do not use a grade of concrete with a specified 28-day compressive strength different from what is designated for the application.

B. **Cementitious Materials Content.** Type III cement is not permitted.

Use combined weight of total cementitious materials when determining compliance with the water-cementitious ratio and cementitious material requirements.

All high-performance concrete requires 25 to 40% replacement of portland cement with supplementary cementitious materials (SCM). For all other grades of concrete, replacing portland cement with SCM is permitted. Unless otherwise specified in the contract, do not exceed a total of 40%

replacement by weight of portland cement with SCMs. Acceptable SCMs are listed in subsections 901.06, 901.07, and 901.08.

C. **Optimized Aggregate.** Optimized aggregate gradation is required for high-performance concrete and concrete mixtures that are placed using a pump. Concrete mixtures for tremie and drilled shaft applications do not require optimized aggregate gradation. Prepare the optimized aggregate gradation and perform process control according to the procedure for optimized aggregate gradation in the contract.

Aggregates for mixture requiring optimized aggregate gradation must meet the physical requirements specified in subsection 902.03.C. The physical requirements for aggregates used in concrete mixtures for all other applications are according to the contract.

When high-performance concrete is specified in the contract, provide Grade 3500HP for mainline pavement, shoulder, miscellaneous pavement (including ramps), concrete pavement overlay applications, and bridge substructure applications; Grade 4500HP for bridge deck applications; and either concrete Grade 3500HP or 4500HP for bridge approach slab applications. The Engineer may approve Grade 3500HP or 4500HP for other applications.

Unless otherwise specified in the contract, concrete mixtures with optimized aggregate gradation may be used instead of standard concrete mixtures, as approved by the Engineer.

D. **Air Content.** Air-entrained concrete is required unless otherwise specified.

The percentage of air in fresh concrete must meet the requirements of Table 1004-1. The Engineer will allow non-air-entrained concrete for use in steel piles that are not subject to freezing.

Use ASTM C231/C231M or ASTM C173/C173M to determine the air content of normal weight concrete. Use ASTM C173/C173M to determine the air content of lightweight concrete and concrete containing highly porous aggregates.

E. **Consistency.** Determine consistency using the slump test in ASTM C143/C143M. Ensure that slump does not exceed the specifications in Table 1004-1.

F. **Concrete Admixtures.** Unless otherwise specified in the contract, concrete admixtures must be selected from the Qualified Products List. The different types of admixtures are listed in subsection 903.02.

For night casting, a water-reducing admixture may be used instead of a water-reducing retarding admixture as long as the concrete can be placed

and finished in the sequence specified on the plans prior to initial set, the concrete is not subjected to residual vibration, and the concrete is not within the areas influenced by dead load deflections as a result of adjacent concrete placement operations. When the maximum air temperature is not forecasted to exceed 60°F for the day, the Contractor may use a water-reducing admixture or a water-reducing retarding admixture.

Ensure that concrete in concrete diaphragms contains a water-reducing admixture or a water-reducing retarding admixture.

Set accelerating admixtures are prohibited unless otherwise specified in the contract.

De-foaming (air detraining) admixtures are prohibited.

G. **Concrete Temperature.** Use ASTM C1064/C1064M to determine concrete temperature.

1004.04. Measurement and Payment

The cost of PCC is included in unit prices for related pay items.

The Engineer's QA test results will be used to determine the pay factor and price adjustments. The Contractor's QC will not be used for pay factor and price adjustments.

Pay factor and price adjustments will be applied according to the contract.

Table 1004-1:
Concrete Mixtures

		Concrete Grade								
		3000	**3500**	**3500HP[a],[b]**	**4000**	**4000HP[a],[b]**	**4500**	**4500HP[a],[b]**	**M**	**X**
Compressive strength (psi)	7 day	2200	2600	2600	3000	3000	3200	3200	Commercial-grade concrete containing 517 lb/cyd. Portland cement may be replaced with an SCM.	Unless otherwise specified, Grade X concrete contains 282 lb/cyd of cement.
	28 day	3000	3500	3500	4000	4000	4500	4500		
	70%	2100	2450	2450	2800	2800	3150	3150		
Flexural strength (psi)	7 day	500	550	550	600	600	625	625		
	28 day	600	650	650	700	700	750	750		
	70%	420	455	455	490	490	525	525		
Slump (inch)		[c]–[f]	[c]–[k]	[c]–[k]	[l]–[n]	[l]–[n]	[d]–[f]	[e]–[f]		
Cementitious material content (lb/cyd)		489–517	517–611[o]	470–564[o]	517–611	517–611	517–658	517–658		
Class of coarse aggregate		[p]–[r]								
Maximum w/cm ratio		0.45								
Air content range		5.5 – 8.5%								
Section reference		402, 403, 602, 803, 804, 806, 808, 810, 813, 814, 819	401, 602, 603, 705, 706, 712, 713, 718, 801, 802, 803, 810, 819	401, 602, 603, 706, 712, 713, 718, 801, 802, 803, 810, 819	705, 922	705, 922	706, 711, 712	706, 711, 712	N/A	N/A

HP = high performance

(a) HP mixtures require optimized gradation meeting subsection 1004.03.C.

(b) HP mixtures require 25 to 40% replacement of portland cement with an SCM.

(c) 0- to 3-inch slump for mixtures for pavements.

(d) 0- to 3-inch slump without admixtures or with Type A or D admixture.

(e) 0- to 6-inch slump after the addition of Type MR admixture.

(f) 0- to 7-inch slump after the addition of Type F or G admixture.

(g) 3- to 7-inch slump for tremie applications without admixture or with Type A or D admixture.

(h) 3- to 7-inch slump for tremie applications after the addition of Type MR admixture.

(i) 3- to 8-inch slump for tremie applications after the addition of Type F or G admixture.

(j) 6- to 8-inch slump for dry placed drilled shafts.

(k) 7- to 9-inch slump for wet placed drilled shafts.

(l) 3- to 5-inch slump without admixtures or with Type A or D admixture.

(m) 3- to 6-inch slump after the addition of Type MR admixture.

(n) 3- to 7-inch slump after the addition of Type F or G admixture.

(o) For concrete pavement repair mixtures, use 658 lb/cyd of cement when the weather is forecast to be above 50°F or 752 lb/cyd when the weather is forecast to be 50°F or below.

(p) Use aggregates only from geologically natural sources for pavement, shoulder, miscellaneous pavement (including ramps), concrete pavement overlay, bridge approach slab, structural concrete, drilled shaft, bridge railing, and bridge sidewalk applications.

(q) Unless otherwise required, use Coarse Aggregate 6AA or 17A for exposed structural concrete in bridges, retaining walls, and pump stations.

(r) The flexural and compressive strengths are not part of the specifications but are listed for informational purposes only and are the minimum strengths anticipated for the mix proportions specified for the various grades of concrete when cured under standard conditions.

Section 1005. Mortar and Grout Mixtures

1005.01. Description

This work consists of producing and furnishing mortars and grouts.

1005.02. Materials

Provide materials in accordance with the following:

A. **Standard Mortars and Grouts.** Proportion cement and fine aggregates as specified in Table 1005-1 and Table 1005-2 by weight for batches of at least 1 cubic yard and by weight or volume for smaller batches. Add water to obtain a mortar or grout of the required consistency.

B. **Non-shrinking Mortar and Grout, Type H-1 (Non-metallic).** Provide Type H-1 non-shrinking mortar and grout, selected from the Qualified Products List, for filling post-tensioning stress pockets in fascia beams of prestressed box beams, under leveling plates supporting structures, for grouting dowels, and under temporary supports.

C. **Expansive Grout, Type E-1.** Provide Type E-1 expansive grout for filling the void around post-tensioned tendons in precast concrete box beams. Proportion the grout as follows:

1. Type I portland cement, 94 pounds;
2. Water no greater than 5 gallons; and
3. Expansive admixture, as recommended by the manufacturer.

Do not use sand in the grout mixture. Do not use grout containing aluminum or other components that produce hydrogen, carbon dioxide, or oxygen gas.

Ensure that grout attains a 28-day minimum compressive strength of 3,000 psi in accordance with ASTM C942, except proportion the grout as specified in this subsection.

Do not use expansive admixtures, plasticizing, or water-reducing agents that contain chloride ions in excess of 0.50% by weight, fluorides, sulfides, nitrates, thixotropic additives, or chemicals that may contribute to stress corrosion in steel.

Provide admixtures in liquid or solid form. Use a gas-evolving material, well dispersed throughout the admixture. Provide grout with an unrestrained expansion from 5 to 10%, in accordance with ASTM C940/C490M, except proportion the grout as specified in this subsection and determine expansion at 3 hours.

1005.03. Construction

The contractor may remix mortars and grouts.

Do not retemper mortars and grouts or use grout and mortar after it begins to set.

Do not place mortar and grout on materials that are below 40°F. Provide protection to maintain a temperature of 45°F or higher during the curing period.

1005.04. Measurement and Payment

The cost of producing and furnishing mortar and grout is included in the unit prices for other relevant pay items.

Table 1005-1:
Proportioning Standard Mortars and Grouts by Dry Weight

		Materials				Mix Proportions by Dry Weight (lb/cyd)				
Mortar or Grout Type	**General Use**	**Portland Cement**	**Masonry Cement**	**Hydrated Lime**	**Fine Aggregate**	**Portland Cement**	**Masonry Cement**	**Hydrated Lime**	**Fine Aggregate**	**Net Water**
R-1 (grout)	Bond or primer coat	Type I, IA	—	—	2NS	1175	—	—	964	705
R-2 (mortar)[(a)]	Patching spalls; filling space between box beams	—	Type M	—	2MS	—	930	—	2137	415
		Type I	Type N	—	2MS	468	349	—	1991	415
		Type I, IA	—	Type S, SA	2MS	828	—	75	2016	415
		Type I, IA	—	—	2MS,2NS	930	—	—	1966	415
R-3 (mortar)[(a)]	Setting precast concrete barriers; filler between slope protection blocks and riprap	Type I, IA	—	—	2NS	765	—	—	2266	353

(a) Provide an entrained air content of 14% ±4% for mortars by using masonry cement, Type IA portland cement, Type SA lime, or an air-entraining admixture. Do not combine masonry cement and Type IA portland cement or Type IA portland cement and Type SA lime unless tests indicate that the air content is within acceptable limits.

Table 1005-2:
Proportioning Standard Mortars and Grouts by Bulk Volume Parts

		Materials				Mix Proportions by Bulk Volume Parts			
Mortar or Grout Type	**General Use**	**Portland Cement**	**Masonry Cement**	**Hydrated Lime**	**Fine Aggregate**	**Portland Cement**	**Masonry Cement**	**Hydrated Lime**	**Fine Aggregate**
R-1 (grout)	Bond or primer coat	Type I, IA	—	—	2NS	1	—	—	1
R-2 (mortar)[a]	Patching spalls; filling space between box beams	—	Type M	—	2MS	—	1	—	2½
		Type I	Type N	—	2MS	[b]	[b]	—	[b]
		Type I, IA	—	Type S, SA	2MS	[b]	—	[b]	[b]
		Type I, IA	—	—	2MS, 2NS	1	—	—	2½
R-3 (mortar)[a]	Setting precast concrete barriers; filler between slope protection blocks and riprap	Type I, IA	—	—	2NS	1	—	—	3½

(a) Provide an entrained air content of 14% ±4% for mortars by using masonry cement, Type IA portland cement, Type SA lime, or an air-entraining admixture. Do not combine masonry cement and Type IA portland cement, or Type IA portland cement and Type SA lime, unless tests indicate that the air content is within acceptable limits.

(b) Do not proportion by volume if blending cementitious materials (portland cement, masonry cement, or lime).